SUPPLEMENT.

The Mining Journal,

RAILWAY AND COMMERCIAL GAZETTE:

FORMING A COMPLETE RECORD OF THE PROCEEDINGS OF ALL PUBLIC COMPANIES.

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The Royal School of Mines, Jermyn Street.

Mr. Warington Smyth's Lectures.

[FROM NOTES BY OUR OWN REPORTER.]

Lecture XXI.—Amongst the preliminary operations of mining those which are called open workings, or open casts, and which include quarries, require especial attention. In commencing operations on beds of coal or of ironstone, it is sometimes more convenient to commence by open workings rather than by sinking a shaft, and occasionally it is preferable even at the outcrop of a lode, although the latter is not a case of much frequency in England. Open workings generally bear considerable resemblance to each other, and the principles by which they should be guided are much alike. The first thing to be done is the removal of the overburden, as it is called—that is, the worthless material which covers the useful minerals intended to be obtained. The greater part of the cost of this kind of work is that required for labour, and the class of men employed are mostly unskilled labourers. Although the labour is of this simple kind, the arrangements often require a large amount of engineering skill and contrivance. These works are sometimes of enormous magnitude, and great consideration, therefore, should be given as to the best means of carrying them out, bearing in mind not only the expense of labour, but the facilities or the want of facilities which the surface offers for the convenience of conveying the useful and marketable commodity to the best point of transit, and of disposing the rubbish so as not to interfer with the workings, and with the least possible cost and trouble. The best place for an open working, or a quarry, is a hill side, and then much depends on the dip of the mineral sought. For instance, if the dip should be into the hill, it will almost always be necessary to run an adit, so as to drain the workings which are to follow. [The general aspect of a working of this kind was shown by Mr. Smyth, by means of a large drawing of an open work at Stanton in Derbyshire.] In this place the workings have more than 60 ft. of height of face, and vast quantities of material being thrown down, the ironstone is picked out at the bottom and stacked until convenient to remove it to the smelter, which is done by means of inclined planes, worked by a steam-engine at the surface. The attle left behind is thrown back, and roughly levelled to a suitable height, and so the ground behind advances gradually as the workings in front progress, and the vegetable earth being replaced on the rubbish the loss of agricultural surface is but small. Another kind of open-air work is that of streaming, which is, on a small scale, something like a quarry. In this case, the bed of a stream is dug out to the depth of a few feet, and, being washed, the tin, the gold, or the diamonds, as the case may be, will be secured, and the rubbish stowed or washed away. But if these superficial deposits of auriferous sand and gravel occur to any large extent, as at Ballarat and in other countries, to a thickness of (say) 30, 40, 50, or even 200 or 300 feet, it is requisite to lay out the workings with careful consideration, so as not to lose any of the valuable deposit. The most remarkable of these stream works in this country are those at Pentnan, in Cornwall, where a succession of steps are formed in the superficial gravel which lies over the tin ore sought for. The bottom, or what is called the shelf, is composed of killas, with occasional dykes of elvan, and over this the steps are formed, so that a number of men can be working simultaneously on each. He explained these steps by drawings, and also showed that, as in many cases works of this kind were often carried for many feet below the streams of the district, it was necessary to have a drain or culvert made of stone, and carried to some point where the water could be got rid of, either naturally or artificially.

If we pass to the working of non-metallic minerals upon a large scale, such as slate, or building, or other stone, we still find the methods employed so various that it is impossible to lay down rules which would be of general application. It may, however, be well to give you a few cautions necessary in arranging the workings, so as to secure remuneration to those who work them. In quarries, and, indeed, in all open workings, there is a certain proportion of rubbish, whether large or small (and sometimes it is a very large proportion), which it is important to get rid of. It is curious to observe how often people begin works of this kind, and often on a large scale, without providing any place in which to put the refuse, and thus are put afterwards to a great expense to get rid of it. Supposing the top consists of a valuable vegetable mould, and the quarry is not intended or expected to be very deep, that mould should be carefully removed to a position from which it may be easily and inexpensively replaced when the bed is worked out. If the quarry be on a hill side, and cut down vertically from the top, a self-acting inclined plane may be used, so that whether the material be valuable or waste the momentum of the descending full carriages will bring up those which are empty from the bottom. It frequently happens that this is the crucial test whether or not a quarry will pay. Beyond this there are other points to be carefully examined. Thus, if the rocks are of a character which permits them to be cut in any direction, there will be no special difficulty; but if they have a definite direction of cleavage, as in slating rocks, then action is limited, and sometimes difficult. We will suppose we have found the site of a promising deposit of slate on a hill side. The manner in which it must be opened depends on the cleavage, and on its direction and inclination. In some districts the dip is almost vertical, as in North Wales, where the largest slate quarries in the world are situate. At Bangor the angle is only 32° or less, and different systems must be followed in the two cases. If you could open the quarry as you liked, perhaps the best thing to do first would be, if possible, to drive an adit level, and thus at once explore the deposit thoroughly, besides draining thoroughly the future quarry, and then begin to dig the ground open in squares, and raise the material, getting it out by the adit. In many cases, however, the cleavage is so distinct that you can only work in one direction. Take, for instance, Festiniog, which possesses the finest slate in the Principality. Here the quarry is on the hill side, above a quantity of material, partly bastard slate and partly greenstone; these are carried back till the wall becomes so high that to carry back the quarry by excavation would necessitate the removal of an enormous amount of material, from 60 to 80 ft. in thickness, so that it becomes a serious question whether it can be worked any further as an open quarry. In Lord Palmerston's quarries it has, therefore, been found necessary to carry the workings underground, and the quarry becomes a mine. This Quarry *versus* Mine question is one on which a large number of lawsuits have turned; but it has been generally ruled that when the work is no longer carried on in the daylight then it becomes a mine, and not a quarry. There are cases, however, in which the transition is very gradual, and sometimes issues involving the ownership of large amounts of property have turned on this point. Sometimes the angle of cleavage deviates slightly from the angle of bedding, in which case the valuable material may be slid down without damage to the bottom. In all the quarries which run along the line of the Menai Straits the angles have this peculiarity; and, being on a hill side, and the cleavage vertical, they often put in a drift. Sometimes the slate has the same cleavage, but at different widths, so that they come occasionally upon a mass of rubbish fit for nothing but to be wheeled away by labourers at so much a-day, and containing here and there fragments of rock so large that they have to be blasted with powder. In some cases the perpendicular cliff created by quarrying is as much as 200 ft., and it is dangerous for the men to work at such a depth, as a comparatively small stone falling on a man from a height of 200 ft. would kill him, and masses of rock are often coming down, especially if on one side the rock be hard. In dealing with gigantic naked surfaces of this kind the most advantageous system to be adopted, if possible, is that worked in Lord Penrhyn's quarries, which employ 5000 people. These wonderful quarries are about ⅓ mile across, and the whole hill side is cut into a series of steps, of which there are 13, presenting the appearance of a vast amphitheatre. On each of these steps a railway is established, besides which a system of inclined planes can be worked. The steps in such cases should not be more than 30 to 40 ft., as if they are more the slate is very apt to crack in falling. If quarries can be hewn into this shape it is most advantageous. Mr. A. Smith's quarries, at Llanberis, have been thus thrown into a good shape, although formerly commenced in a bad form; and we see generally, wherever good quarrying is carried on, it is done in some well-considered systematic form, devised according to the circumstances it has to meet. This form is generally a succession of steps, as by it the possibility of employing the largest number of men is secured. With regard to rubbish, a great deal is made in getting slate, so that a great deal of space is required. For every ton of good slate from 15 to 20 tons of rubbish may be reckoned, and, therefore, it is almost impossible to exaggerate the importance of providing a place for it; and there are numerous cases in which, when a sufficient provision has not been made at first, long lines of rails have had to be laid down to carry away the broken material.

Another class of open workings is exceedingly interesting from the associations connected with them. In the earliest times metalliferous mines were frequently commenced on the lodes by open workings. Accounts are to be found in the older authors of workings of this kind on a large scale by the Romans in Britain, the Germans, and other peoples. The surface was removed in steps of 6 ft., the refuse being thrown up from the bottom with the shovel, and so passed up from step to step. There is much danger in this system of the earth falling in, but in Cornwall there are examples left in which the earth has been scooped out bodily to a depth of 60 ft. This system is also interesting, because it represents very nearly the system of working usual when the workings are carried to a great depth, and when it becomes necessary to place beams across to resist the side thrust, and to pile upon it a great deal of rubbish, which is not wanted to be taken to the surface, and by this means to strengthen the ground. In Scandinavia these open casts are worked even now with great advantage, and to a large extent. In several places on the Continent iron ores are obtained by vast open workings, and in some copper mines in the Isle of Anglesey, called the Parys and Mona Mines, the open casts are more than 100 ft. deep, and the cliff, marked with the varied and glowing tints produced by the copper and the iron pyrites is a beautiful object. In Norway and Sweden we have larger ones: especially may be mentioned those at Arundal, where the deposits are taken out bodily, and are approached by an adit or level, and the water pumped out. The most remarkable of these open casts is that of Fahlun, a copper mine in Sweden, where a gigantic open cast of 200 or 300 feet deep exists. We must, however, to open out such workings remove an immense quantity of rubish, and the sides are constantly tending to fall in. At the Parys and Mona Mines for fathoms many great rifts and fissures can be seen, and occasionally immense falls occur. So it is not advisable to take down an over-cast more than 100 ft., or even so much as that, if the rock is not hard.

In Transylvania remarkable open casts (this term is applied to metallic deposits) were worked by the Romans for gold in the times of Trajan and Hadrian on an immense scale. At Votos-potock a great skeleton of these works is left; parts here and there having been worked out, and the rest left. Very much the same sort of thing takes place in the North of Spain, where large deposits of calamine are thus worked. In Scandinavia the deposits of magnetic iron ore are sometimes very wide, and so they are worked by open casts. In cases where such large lodes occur it is often difficult to decide whether the work should be commenced by an open cast or a shaft. A lode 50 ft. wide might very well be worked by an open cast, but then comes the question of timbering the excavations, and it may often be better to attack the deposit by subterranean workings at once.

Lecture XXII.—Our lecture yesterday was devoted to the opening of quarries and works open to the eye of heaven, and we may very well take next the question of how the workmen are to be lighted when they descend below the surface to depths of greater or less profundity. In dealing with this subject it is necessary to make a broad distinction between the mines in which explosive gases are more or less always present, and those in which they are mostly absent. Although metalliferous mines have here and there met with mishaps in consequence of fire-damp, it is generally unnecessary to provide against that dangerous element of destruction, and open lights may be employed with safety. In the early days of mining rude lamps, and even torches of pine or other resinous woods, were used so as to last out through the eight-hours work in which the miners usually engage. Certain ancient mines were worked with an extremely small modicum of light, the mineral being handed by the workmen from one to another, but in the present day the most simple kinds of lights used are candles, or lamps of a primitive pattern. I will first say a word or two as to candles. In the greater part of the metalliferous mines of this country nothing else is used. They vary very much in size, ranging from 6 to the lb., to 30 or 40, and even 50 or 60 to the lb. Candles of this attenuated kind were formerly employed largely where the collier had to depend on them to indicate the fire-damp; and his own life and scores of lives would hang on the care and judgment with which the quantity of explosive gas in the atmosphere was tested by means of a candle. Before Sir Humphry Davy's lamp was invented no other test was employed. The miner would advance very carefully to the place at which fire-damp was said to exist, holding the candle between the palms of his hands. Progressing very cautiously, he would observe what effect was produced on the flame of the candle by the movement. As soon as he reached any considerable quantity of fire-damp the flame would begin to elongate and change colour, and this colour would vary materially, according to the actual constituents of the gas. Some mixtures have more degrees of danger than others, as it is diluted with pure or impure air, or carbonic acid gas. Thus carefully progressing, the observer would be able to tell by this elongation and colour whether or not the gas is what is called "quick," or ready to explode. Some men would often carry their daring so far as to go on till the flame appeared almost ready to leap off the candle, within a hair's breadth, as it were, of exploding, and dealing destruction to all around. The introduction of the Davy did away with the necessity of this mode of testing, and although small candles are used for many purposes in collieries, the very attenuated ones I have mentioned are not now employed. Furthermore, so many mixtures of various kinds have been employed for candles of late years, that it is difficult to say which are the best; but, as a rule, it is wiser to give a good price, and get a good article. When a bad article is used the workmen have a feebler light, and cannot do so much work, and it is, therefore, better always to buy of some well-known maker of character in the gross, and issue them to the miners at as near cost price as possible. There are many ways of holding the candle while at work, the simplest of all is to well temper a piece of clay to the proper consistency, and placing the candle in it, stick it on the wall at exactly the place where the light is required. Sometimes the miners place the candle in their caps when moving about, so as to leave their hands free for action.

On the Continent the candle is carried in a wooden box, the back of which being fitted with some shining substance, gives by reflection a very good light. These boxes are so contrived as to fasten to the dress, and are thus carried very easily. In some places tallow is burnt in lamps instead of oil; a very common practice in Eastern Europe, as, for instance, in the Carpathian Mountains, and it is a matter of dispute whether oil or tallow is the most economical. In deep metalliferous mines the height of the temperature renders the use of candles inconvenient, on account of their tendency to become soft, and run down. It is usual, therefore, in such mines whenever open lights are used to have lamps; these vary very much in shape, and a number of specimens on the table illustrate well the different kinds in use, not only on the Continent but in England. In Hungary and the Hartz, in the mines of Siegen, of Prussia, of Westphalia, and of Spain oil is universally used; but none of them for economy surpass the Scotch lamp, which costs about 2½d., and will burn three hours for 1d. Some of the foreign lamps have reflectors of polished brass or of silvered glass for use in large excavations. I lately visited a large mine in Belgium, and found there a form of lamp said to be very effective and economical. It had a spheroidal shape, and with colza oil was stated to burn 10 hours at a cost of no more than 1d.

We now pass to a far more important subject—that of obtaining a satisfactory light for the purpose of working fiery mines. I need not say anything about the difficulties that had to be encountered before the discovery of that peculiar quality of wire-gauze which prevents the passage of explosive gases. Men were then at a premium who could work in the dark for certain purposes in dangerous atmospheres, as, for instance, in drifts, where it is impossible to go further with naked lights, and so everything depends upon getting an opening through for ventilation. Very curious ideas have at times prevailed as to how light could be obtained without incurring the danger of setting fire to the gas. For instance, it was at one time attempted to pass the light in, as it were, by a succession of reflectors, but the attempt was soon found to be futile. The expedient of the Chinese miners, of confining fire-flies in a bottle, is found in that country, where they are plentiful, somewhat better, as the fire-flies there give an extraordinary amount of light. About the end of the last century a steel mill was used, by which a continuous shower of sparks were thrown off, and gave a sort of light. A specimen of this contrivance is upstairs in the Museum, but I should think that now there is scarcely one in existence elsewhere. It was believed for a long time that sparks were not sufficiently inflammable to ignite the fire-damp, but two or three accidents occurring when the steel mill was employed the device came to be looked on with suspicion, and it became necessary to introduce some other system of lighting. It is curious now to see how long the steel mill was adhered to, and it was called "the miners' best friend." I shall not detain you by giving the history of the safety-lamp, or the series of experiments by which Sir Humphry Davy demonstrated that a close wire gauze would intercept flame; so that if you take a lamp known by his name, "the Davy," and fill the inside with flame, the wire gauze of which I is made will prevent that flame from spreading to the exterior. I propose merely to mention some of the improved lamps which are now in use, or have lately been proposed.

Sir Humphry Davy himself, in a lecture on the subject, pointed out two or three weaknesses in his plan, but as a rule, accidents which occur where it is used are rather attributable to a want of proper caution than to the lamp itself. The lamp should only have a moderate height, such as 6 or 7 in., and 1⅜ to 1½ in. in diameter. If the lamp be made of a large calibre it is no longer safe. Thus the size of the mesh is important; the proper size giving 728 apertures to the square inch. If these conditions are not observed the lamp is bad and useless as regards the element of safety. It is a moot question whether it is better to trust to ventilation to sweep away all gases as soon as they appear, or to give the men safety-lamps. There must, however, always be a broad line drawn between a certain class of mines and others. No doubt the men work better when an efficient ventilation allows them to use naked lights; but when a mine is exposed to sudden outbursts of large bodies of gas, then it is obvious that safety-lamps must be used, as no one can possibly know before hand when such outbursts will take place. One of the weaknesses of his lamp which Sir Humphry Davy pointed out (and it is one which applies to the modern improvements upon it, more or less) is this—if the lamp be carried in a quiet way, and kept upright, its efficiency is undoubted; but if it be exposed to a current of air of a given velocity it is no longer safe. Thus, it is not safe to move it at the rate of 3 or 4 ft. in a second, as in that case there is a risk that the flame would be blown through the gauze. This danger is, however, easily obviated by placing the lamp, when in a strong current of gaseous air, within a cylindrical tin box. But the small quantity of light produced by the Davy lamp is the chief objection to it, as that constitutes an incessant temptation to the workmen to unscrew the top, and so gain the advantage of a naked light for their work. This, no doubt, is frequently done, and is, perhaps, the cause of many accidents, although any workman detected in unscrewing the gauze of his lamp is now liable to a severe penalty, and miners are often sentenced to one, two, or three months' imprisonment for thus endangering, not their own lives only, but the lives of all who are at work with them in the pit. Early attempts were made to obtain more light, and still use the Davy principle, and at about the same time George Stephenson and Dr. Clanny brought out excellent lamps, of an almost identical principle, but which they had adopted quite independently of each other. These differed only from the Davy in being of larger dimensions, and, therefore, giving a better light; and they surmounted the philosophical objection to the size being enlarged by placing a glass cylinder within the gauze. These lamps are much used in this country, and are called by the miners "the Geordie." It was said that the glasses of these lamps would be constantly breaking, and that then there would be great risk of explosion, but actual experience shows that there is but very little breakage.

Besides these there were other good, though less used, modifications of the Davy, amongst which that of Mr. Byron, late the agent of Lord Fitzwilliam, might be specially mentioned as producing by parabolic reflectors an admirable light. It is, however, rather too slight in its construction. But the whole series of lamps, however good their construction, would, even if they were faultless, be insufficient to ensure safety, unless they were locked or secured so that the workman could not get at the naked flame. Many contrivances have been devised to obviate this difficulty. In Belgium they have a lamp in which unscrewing the cover would put out the light, but that might be evaded by inserting a pin through the gauze. One of the best of these contrivances is that of M. Dubruiller, the effect of which is that any tampering with the cover draws down the wick, so that the light must be put out. Another good one is that of M. Mueseler, much used in Belgium, of which there are 24,000 at work every day in the collieries of that country. It is a lamp which gives a good quantity of light, and thus takes away much of the temptation to unscrew the gauze which a gloomier light produces. When exposed, however, to a rapid current of air (say) of about 8 or 9 feet per second, this lamp, in common with those of Davy and others, is not secure. It is, however, a good lamp, as indeed are all the four permitted by the authorities to be used in Belgium. Several good safety-lamps are also due to French inventors; but Dr. Pereira, by numerous and conclusive experiments, has proved that, with every contrivance and with every guard that science or ingenuity has yet suggested, absolute safety has not been secured; for, putting aside the carelessness and tricks of the workmen, the protective power of gauze does not exist in currents of air of an ascertained rapidity. Thus, there is danger if the person carrying the lamp happens to stumble, or if the lamp were swung. During the last few few years a committee of coalviewers has made many experiments on this subject, which have resulted in the corroboration of the fact that no lamp is safe if exposed to a current of air of 8 ft. per second. On a comparison, however, of all the various safety-lamps in use, it is allowed that none have proved, on the whole, to be better than that of Stephenson, which has stood its ground on many occasions when others have failed. Any improvement, therefore, in this mode of obtaining the requisite light must be looked for by modifying the "Geordie."

Lecture XXIII.—The subject of lighting the mine (said Mr. Smyth), on which we were last engaged, is one which you will recollect must vary very much according to particular circumstances, and whether we have to deal with metalliferous or non-metalliferous deposits, and whether or not safety-lamps must be used. With regard to the lighting of fiery mines, a series of rules must be observed with the greatest strictness—rules, the importance of which will be even more apparent when we come to the proper division of the works, and keeping distinct the places where naked lights are used, and those where safety-lamps only ought to be employed. This latter is a matter of great importance, on the observance of which the safety of a great many lives may depend. A great many explosive gases may be given off without danger if they are given off in quantities so regular that they can be disposed of by ordinary ventilation of mines, and then naked lights may often be used throughout; but in a certain number of mines it becomes necessary to make a distinction between those parts in which the men can work with naked lights, and other parts in which the gas exudes not in moderate and regular quantities, but, perhaps, largely, and in blowers, and where none but safety-lamps should be allowed. Even where the gas is usually present with regularity and moderation, if there is a liability to falls of roof, certain portions of the workings must be set aside for the use of safety-lamps alone. Suppose, for instance, a fall of roof were to take place, the result often is a sudden incursion of gas, and then, if in that portion of the mine the lighting is carefully restricted to safety-lamps, the chances of an explosion are greatly lessened; and, indeed, if the lamps are all in proper order there will be no accident, but the discipline of the men ought to be so exact that if a man's lamp goes out in such a district he ought not to think of using a match to relight it, but find his way back to the lamp station for that purpose. These are points I merely indicate in passing, because we shall see them more clearly when we come to deal with ventilation and the arrangement of the workings. To-day I propose to take a general review of the different forms of working, both in metalliferous deposits and in stratified ground, whether of coal, ironstone, or other like minerals. Of course, if the minerals deposited are of an extremely varied character, we cannot lay down any definite forms which the workings should assume; and so, as in the mines of Scandinavia, to which I have so frequently referred, they begin with a great open-cast, which at last becomes too dangerous, and then they are carried on with regular underground workings; or, to take another case of this sort of irregularity, that of the white earth mines at Aue, near Schneeberg, in Saxony, where large bosses of granite between the clay-slate rocks are so changed as to allow the felspar to be extracted as china-clay, but being in uncertainty how far this changed character will extend, or with what thickness, the workings assume a form very irregular in many respects, as if they were feeling their way in the dark; but at last when some sort of certainty is arrived at, the deposit is removed by a series of regular stopes. When, however, we come to anything like stratified rocks of considerable area, as coal or ironstone, or anything in metalliferous deposits which extend in the direction of regular veins, then we may look forward to works of a regular character, and it is important to look before hand how they are to be arranged, and what form they are to take. In the first place, it may be noted that workings on stratified deposits and on lodes are similar in certain great essentials, while they differ in most other points. If we look at a seam of coal or any other bedded deposit, the form of working will be found to have depended upon the area of the ground to be worked, the nature of the deposit itself, its thickness, and extent of the demand for it, and whether there will be a large or a small market in which to dispose of the mineral. In looking at the area to be worked, careful observation must be made as to the direction in which the general dip lies, and what is the direction also of any known lines of dislocation. In some districts dislocations are so numerous that the divided portions of a seam cannot always be worked together, and thus it may be necessary to divide the works. Supposing, however, we have to deal with one or even two square miles, one set of shafts will be sufficient; and, as a general rule, the deepest point attainable will be taken as the place where the shafts should be sunk, and towards which the system of drainage in the mine must be made to tend. Supposing that the general dip of a measure is lower at one point than another, it is sometimes a matter for consideration whether it should be put down

at the deeper or the shallower place, and the question will be decided by the capital at your disposal and the time over which your lease extends; and, therefore, upon the magnitude of the whole of the operations and difficulty of sinking. In Staffordshire and Wales, where the pit is sunk is a matter of comparatively small importance, but in the North of England it is a consideration of the utmost moment, as they often cost there as much as 60,000l. or 80,000l., and, therefore, it is important that the goodness of the coal and the other circumstances will allow us, if we sink a pit at such a large cost, to recoup ourselves by what we get out of it. Next to this comes another point of importance, where circumstances will allow of its being carried out. Supposing we have obtained access to the coal at a given point, but that it is in a hilly district, such as we meet with in South Wales, the West Riding of Yorkshire, and some parts of Lancashire. If the seam dips from the hill side into the deep the question is whether we should not run an adit at a lower point, and so drain the whole. In other cases an adit might go along the inclination of the coal, but it will mostly have to be driven through dead ground. It may serve the purpose of an exploratory level as well as assist the drainage, and thus assure the adventurer that the entire field is in a proper condition for working, and not interrupted with faults. Levels of this kind are also driven from the pit bottom, and it is not until a considerable distance from that point has been arrived at that we can expect to raise coal on any considerable scale. We must be prepared, therefore, with capital not only to sink our pit, but to leave a considerable portion of coal around the bottom in what are called the shaft pillars. Many otherwise good collieries have been ruined by getting coal too soon. It is very natural that the proprietors should want to get a return as speedily as possible for the money expended, and so the shaft pillars are left on too small a scale, and the safety of the whole is endangered. In the smaller Staffordshire mines this is a matter of less consequence than in the North, where great areas are worked by one set of pits. In a good shaft, however deep, daylight ought to be seen from the bottom, but there are plenty which, owing to the insufficiency of the shaft pillars, turn and twist like a cork screw. This naturally makes the shaft insecure, and pieces falling in from the sides often endanger the lives of the workmen. It is, therefore, very important that a certain amount should be left all round the pit bottom, the levels being driven through to a safe distance, when the work of removing the coal may begin.

The lecturer then pointed out on several large plans the masses left, as pillar shafts entirely unworked, except the narrow drifts through which the regular workings were reached. The same principle goes through all the workings; beginning first by getting a small quantity, and then removing the pillars between each opening, and gradually obtaining a large "get" of coal. In cases of small area it is safer to drive out to the extreme boundary, with exploratory and other drifts following the boundary all round before you begin to remove coal within that boundary, if you can afford to wait so long. You then take slice after slice, leaving all behind you in a state of goaf, and giving no further trouble either as to roadways or as to freedom from gas. That is the safer method, but more frequently a mine is worked *from* the pit instead of *to* it. This is more dangerous, because the goafs are left near the shaft pillar, and in them there is likely to be accumulations of gas; and if roadways are carried through them these goafs are a source of constant difficulty and danger. These risks are, however, encountered because the other plan involves the necessity of a quantity of dead-work before the coal can be removed with advantage. When we have planned our mine, and it is one from which we propose to raise largely, it is important to properly place the machinery, and to suit it to the work intended to be done. We may start with an engine for pumping, which may serve for a time for winding as well; but it will generally be found advisable to erect permanent machinery for pumping only, and other machinery for winding only. This may be calculated exactly by its capability of raising so many hundreds of tons of coal per diem, and the power requisite to keep the ground clear from water, and the best means may be taken to raise first one and the other; but it is a very different thing when we come to metalliferous mines. In these no one can tell whether that which is sought will be found at 3 fms. or 300 fms.; and every yard they go down, and every horizontal cutting they enter upon, is like a new speculation—so thoroughly uncertain is metallic mining, except under very favourable circumstances indeed. In metalliferous, as in stratified, mining a commencement is made by a shaft. If there be a valley, an adit is driven in the first instance for drainage, which is often continued as exploratory, and one or more shafts are sunk down to it. We have seen that in copper mines the gossan often goes down to great distances, and in those cases it would be useless to excavate a shallow level. The question for solution, then, is how far should the miner go before endeavouring to get hold of ore enough at least to pay for expenses. When it is supposed that orey ground is reached the ordinary distance at which the levels are placed asunder is 10 fathoms, each new level being driven out to explore. If the appearances are favourable every prudent manager will proceed to sink the shaft still deeper, so as to disseminate, as it were, the cost of the dead work over the whole operation. It will always be found that when shareholders are accustomed to receive a certain dividend they do not like to have, on the contrary, to pay a call, which would be the case if every orey portion of ground were exhausted before further exploratory or dead work were done. The men should, therefore, be kept on sinking the shafts, and the levels should be pushed on through dead ground to see if anything better exists beyond, while in other portions of the mine are produced the marketable minerals, from which the dividends are derived, and by which the expenses are covered. To save expense in mines, when the nature of the ground is well understood, it has been suggested that the levels should be 20 fms. asunder, as, indeed, it is the practice in Saxony, but in this case difficulties on the score of ventilation will arise, and the managers would probably have to put in a sump, or small shaft, between the levels; and as this work is done with a windlass the miners do not like it, and so the 10-fathom rule is generally adhered to. Driving these narrow levels, however, costs so much a fathom, and the intermediate spaces are worked out at a quarter of the expense by stoping, and the greater part of the cost of an intermediate level would be saved. If the lode is subject to great and frequent variations, it may not be desirable to lessen the distance, as in that case productive ground might be missed. In a very few mines in this country a compromise has been tried, and the levels are driven at 15 fms.; and where the lode is poor, and shareholders are getting dispirited, it may be well to do this, in the hope of finding a change for the better. In any case, however, and I am anxious to impress this strongly upon my hearers, there ought to be a certain relation between the money spent in constantly advancing these preliminary works, and that spent in working away the ore. This rule is observed in all good mining. It is difficult to fix on any general proportion to be observed. That will vary according to circumstances. At Pzribran, in Bohemia, one-third of the men are employed in removing ore, and two-thirds are kept at the work of exploration; and, undoubtedly, if a mine can be kept going on this scale there is every probability that it will last for many years, and be productive. The narrow work of sinking and driving is tutwork, and as long as that goes on in a regular manner, there is always a chance of what is called "a discovery"—that is, coming upon orey and productive portions of greater or less value, and the skill and judgment of good managers will always provide for new explorations after every such discovery. What would be thought of a mine where, when a discovery is made, all the hands are put on at that place to realise the riches as speedily as possible, to the neglect of exploratory work, but that it was fast hastening to its end. Whenever tutwork is stopped in a mine, its managers are committing suicide, and unless additional capital can be raised such a course must end in destruction. In many of the smaller mines this constantly happens. A party of adventurers take up a mine of this sort, and when they cut into a little ore all the men are crowded upon it to take it out, and so the enterprise speedily comes to an end. It is unusual, no doubt, to see such masses of ore as those opened out on Teague's lode, but a glance at the plan will show that this mine would never have existed in its present magnitude if tutwork had not been systematically carried on, as the shafts and levels go through large spaces of dead ground, and then come upon vast masses of rich orey mineral widely separated from each other.

I may here again observe that there is the greatest difference between mining of this kind and that in the stratified deposits. In the latter, the machinery can be put down from the commencement, where it will remain, and the whole arrangements well thought out; but in the metalliferous lodes you may begin by putting up horse-whims to draw up the water, and then a steam-engine, but whatever is done must be marked by the strictest economy, and be consistent with the idea of giving that attempt up altogether, and shifting the operations and the whole apparatus to another place. Again, in the stratified deposits there is invariably vertical, but in metalliferous mines they very frequently are slanting, following the direction of the lode, and that, too, at a very low angle of inclination. Local circumstances occur which render it impossible to sink vertically. Thus, at Botallack the shaft commences at a short distance from the water, and then penetrates in a slanting direction until it reaches a distance of many fathoms under the sea, and it is an example of great interest.

In conclusion, I will make a few remarks on the mode in which various kinds of workings are represented on maps. With regard to stratified deposits there is not much to say. The unworked portions of a seam are almost always represented by a dark tint, and white lines show the actual breadth of the excavations. Although there are excellent pillar workings in existence, we are left with extremely little information respecting those of the older dates. Neither proprietors, managers, nor lessees know what there is or what there is not, and, no doubt, in these mines a great deal of coal is entirely wasted. It is useful to have different colours for different levels, but when there are three or four seams of coal within 40 or 50 yards the plans are apt to become complicated. On the Continent great progress has been made of late years both as regards the mapping of seams of coal and lodes, and the workings of both.

Mr. Smyth then exhibited a large number of specimens of both foreign and English maps and plans.

LECTURE XXIV.—We will devote an hour to-day to the description of how the miners gain access to their work, as it is a subject of considerable importance, not only as to their safety and convenience, but as to economy both of time and labour. This is especially the case when a mine has attained a considerable depth. In the earliest stages of metalliferous mining the men were simply lowered to their work by a windlass or by a steep ladder, and that is the case now so long as it may be near the surface, but when a mine descends a hundred or more fathoms, and an army of men are employed, the matter becomes one of serious importance. Indeed, if we examine the statistics of mining accidents we shall find that a very great many are caused in travelling up and down the shafts. It is not surprising, then, that they are a constant source of anxiety, and that not only as to the safety of the men, but as to the effect produced by the modes of ascent and descent upon their health. The old author, Agricola, to whose writings I have before referred, gives an account of all the apparatus employed in his day, and some of them in the manner of access to the workings are still in vogue. In the first place mines of a small depth are worked by a downcast, made in a succession of stopes or steps, almost like the ordinary plan adopted in a cutting for a railway. In Derbyshire many of the iron mines are so arranged, and a few steps suffice to get down to the work and back. Again, there was another plan, no doubt derived from that, in which steps are cut in the rocky floor of the vein, sometimes throughout the plane of the lode itself or the conterminous rock; and there is a convenience in this plan when it is desirable to introduce horse-power, as the steps can be made sufficiently broad, and of a moderate height, so that horses might be taken up and down. This is a common practice in the Mostyn Mines, in Flintshire, in some lead mines in Great Britain, and the salt mines at Wieliczka, in Poland, at the Monte Catini workings, and in the Beaumont Mines in Cumberland. This is a matter which depends much upon the depth, an increase in which has led to modifications of the plan in the salt mines of the Alps, where the steps are cut with slopes between at an angle of 33°. This may not appear a very serious affair, but it is important in every case to make the descent and ascent to and from the work as easy as possible. In the quarries in North Wales, where a hard stone is worked in sets, there are escarpments with rails between them, which run at about the angle of 35°. This is the most convenient amount of rise in the steps or ascent that can be adopted. If the gradient be raised to 45° it will be necessary to have a hand rail and approximate to the conditions of a ladder. A variation in this is a curious system they have in use in the salt mines of the Alps, in which there are inclined shafts, with steps on the side made of pieces of timber at each step to tread on, but having besides a couple of rows of rounded pine timber, upon which the miners slide down in a sitting position, shooting to the bottom with wonderful rapidity and perfect security. The next step is to those vertical shafts which are ascended by ladders. If we pass to the smaller lead mines of the North of England we shall find that they have very rude methods of descent, and that in many cases in Derbyshire also it is effected simply by a number of pieces of wood projecting from the sides of the shaft, driven in between the stones of the walling. A great inconvenience attends this plan, as there is often a strong draught, which may extinguish the light carried by the person descending; and then, if two or three of these pegs be worn or knocked away in succession, he is exposed to great peril. This plan is, however, only used in mines on a small scale. The next step to this is putting in stemples, which are placed across at 4 feet asunder, sometimes parallel and sometimes transversely. In the winze, where it is not more than 2 or 3 fathoms long, these are very suitable; and thus instead of regular ladders, the men climb up and down by the help of a cord. When, as in Yorkshire, the stemples are placed where the depth is from 40 or 50 fms., it is very hard work, and they are so large for the hands that those accustomed to a good ladder will not approve of them. Ladders are the ordinary means of descent in most properly managed mines when machinery is not employed for lowering and drawing out the men. The simplest kind of ladders are those in use in America, in Hungary, and in some parts of the North of Europe, and it is a kind which is the most advantageously employed when blasting is going on, and when, consequently, smaller ladders would be knocked to pieces. It is formed of a strong beam of wood, in which steps are cut at proper distances. Another sort is very often used (although it is not to be recommended where there are a great number of men), in which strips of wood are nailed across an upright, like a poultry ladder, and placed against the sides of shafts for a considerable height. Wherever it is used, better means ought to be adopted for fixing the cross-bars securely. The staves of the ladders in Saxony are usually flat, and are put through holes in the side pieces. In England they are usually round and made of ash; with, in Cornwall, at the distance of every ten or eleven, a strong wrought-iron stave, which holds the ladder firmly together. As a rule, iron staves are not advisable, and in winzes and places not often travelled through they will sometimes be found to have utterly perished, so far as strength is concerned, nothing being left but a mere crust. The distance at which the staves are placed asunder is a question which very greatly affects the comfort of the men. If they were as close as those of a bricklayer's ladder nobody would like them. It is usual in mines to have them from 10 to 12 in. apart; 12 inches, however, are found to be a great pull upon ordinary legs, and 10 in., on the other hand, is too short a distance: 11 in., therefore, will be found, as a rule, to answer best, and that rule is generally adopted in Cornwall. Ladders are sometimes made of chain, for the purpose of being used in winzes, and are so far convenient that they can be raised from places where they are seldom wanted, and removed elsewhere. It has been proposed in Belgium to substitute for ladders wrought-iron staircases of a spiral form, winding round a perpendicular centre; and that plan might be useful to be used when any accident happens to the machinery, when the men are raised and lowered in that way. Thus, I remember a case, and probably it is not a single one, in which 100 men were left at the bottom for a whole night, because an accident had happened to the machinery, who might have ascended had there been a ladder-way; and you may remember the fearful accident at the Hartley Colliery, where a ladder might have been the means of saving many lives. Although it is to be hoped that ladders will some day be almost entirely superseded in regular work, and only retained for the exceptional cases, they are yet so numerous and general that it is a question of great importance to the mining engineers to consider how he may best place them. If we have an inclined shaft 450 fms., it is convenient to put the ladder along the footwall of the lode, but not close to it, so that any rubbish falling may pass through. In vertical shafts the ladders must be placed at an angle which is easy to climb, although a great deal will depend upon the size of the shaft. This is a subject which requires great care. At this moment a great number of our mines have the ladders placed so badly, that where there are considerable distances to climb the health of the men is most seriously injured. It must always be remembered that these things are better done properly at first, as it would cost a great deal of money and time to take out a set of ladders and replace them with better. The worst ladders are those which rest upright against the wall of the shaft, of which there are not so many cases now as there used to be. A daily ascent and descent of 50, 60, or perhaps 80 fms. upon a perpendicular ladder is found to affect the heart and lungs very powerfully and injuriously, besides the danger of instant death by missing foot-hold or hand-hold. In such a case the centre of gravity being outside the ladder the unfortunate miner falls clear, and is dashed to pieces; whereas, if the angle of inclination is sufficient he falls upon the lower part of the ladder, and has at least the chance of grasping some of the rounds. It is now, therefore, considered necessary to give an angle of inclination (say) of 75°, which a man in good health may use without great exertion, and without prejudicial effect upon the heart and lungs of any kind, besides which such ladders are much less dangerous. The question, then, is how to get that angle where the shaft is perpendicular. This is done by a system of sollars, by which the descent is divided. Each of these sollars has a man-hole, with a trap-door, so that in case of accident a man would not have a fall which must necessarily be fatal. In the Hartz and in Norway, where everything is done that is possible to be done for the health and safety of the workmen very short ladders are used, the length not being more than 2 fms., and each sollar is well guarded with sides. In Saxony and in Cornwall lengths of 4, 5, and 6 fms. are common. In the ordinary run of English mines, from 20 to 40 fms. are the lengths which prevail. These long lengths, however, are all more or less painful and fatiguing, and in the deeper mines the average life of miners was shortened in consequence of this, the vitiated air they breathed, and other reasons, so that many plans were proposed to get rid of this labour. A great point in this problem is the consideration that the men are working at various depths on different levels, some at the bottom and others it may be half-way up to the surface, so that while some have but long distances others have but short distances to climb. Then, again, there is difficulty in introducing machinery when the shaft is not suitably inclined or perpendicular. These and other cognate problems were discussed for years; and one of the first attempts to meet the difficulty in this country was by raising the men by means of the same rope and chain which raised the mineral, but it was found so full of risk that the proposal (and in metalliferous mines especially) was not received with any satisfaction. It was found, from comparative statistics, that there were more accidents when the men were raised by rope or chain than before, and it was wondered they were not even more numerous. In Belgium, for instance, the accidents in one year where ladders are used were only 1 in 2661; while at Charleroi, where ropes and chains are used, the number of ascents and men being equal, the fatality by accidents were as many as 1 in 1153, or more than double. At last in the Hartz mines a discovery was made which led to a new method, which came into use in 1839, which solved the difficulty, while our miners in Cornwall were close at their heels, and originated the very same thing. This machine, which is called the Fahrkunst, in Germany, was put up in the Tresavean Mines in 1842, and the inventor received a prize offered by the Polytechnic Institute of Cornwall for this great improvement, by which the men were lowered and raised without taxing their physical powers. The importance of the change will be obvious if we consider the actual loss to proprietors of work (let alone the wear and tear on the men), as it often takes half or three-quarters of an hour to go down and to come up. Let us suppose 600 men are employed, and have to descend 1200 ft. to their work, and that each man weighs 120 lbs. Each man will have, of course, to lift his own weight, and, therefore, the whole will lift—600 × 120 × 1200 = 86,000,000 lbs. To raise one million of pounds a foot is a good day's work for a man, so that there is lost the work of 86 men. Taking each man's labour as worth 3s. a day, that gives a total of 12l. 18s. loss in money value per diem, or for 300 working days in the year, 3870l. per annum is lost. This is a sum large enough to put up a steam-engine, to raise and lower the men by machinery. The apparatus thus found to be so serviceable, and which, as I have said, is called the Fahrkunst in the Hartz, is called the man-engine in Cornwall, an unsatisfactory name, but it means the same thing. The idea was hit upon in a similar manner, both in the Hartz by Mr. Oppenheim, and in Cornwall by Mr. Lewis. Watching the action of the pumping-rod, the two observers conceived the idea that by making a foot-hold on the rod the miner would be drawn up as much as the length of the stroke at each stroke, when he could step off on to a platform, and then on to the rod on the other side, which would just have completed the down stroke, and would be ready to ascend. At first it was intended that only a few men should ride in this manner on the pumping-rod. The shaft being all open and unprotected, it required a good deal of nerve to step across the yawning abyss below, but it was found so advantageous that, eventually, arrangements were made to carry all the men; and at Mansfeld, in Prussian Germany, a plan was adopted by which the platforms nearly touched each other, so as to avoid this danger. In Cornwall the ascent and descent is made in a similar way, but independently of the pumping-rods, by what, as I have said, is called by the miners there "the man-engine." The simplest form is that used in Cornwall, but double-action machines are now common in Bohemia, Saxony, Belgium, and almost all the northern mines on the Continent. In England a great improvement is made; instead of two rods, a single rod is put in, the steps being 2 fathoms apart, and at corresponding intervals sollars are constructed, which the steps all but touch. It makes about eight strokes in a minute, and 12 ft. at a stroke, so that the rate of ascent or descent is 12 ft. in a minute. The expense of this single rod system is not considerable; and wherever a shaft is 150 fms. deep or more, a man-engine may be put in. There is good reason for believing that this mode of conveying the miners up and down the shaft is in the end a great saving to the proprietors of the mine, to say nothing of the great boon it is to the men in getting rid not only of the inconvenience of climbing, but conferring upon them many more years of health and usefulness than they formerly attained to. Thus the man-engine is a great advantage to all persons concerned, and ought to be introduced in all cases where the shaft is 150 fms. deep or more. Most admirable machinery of this kind has been put up by M. Warocque, at his colliery at Mariemont, where the step is large enough to accommodate two persons at once, and so well boxed in that all risk seems to be removed. It is placed in an elliptical shaft, and every day 700 persons go up and down without any sort of fatigue. It is rather expensive, but as four collieries have access to that shaft it is looked upon as a great boon.

LECTURE XXV.—In our last lecture I explained that where ladders are used much depends on their construction, and the manner of placing them. When blasting is going on chain or wire-rope ladders are often used, so that they may be hauled up out of harm's way. I also pointed out that the variety of ladders is very great. In a deep copper mine, in Sweden for instance, wire-ropes and chains instead of wood staves are much used for ladders, but great care is taken to make the lower ends tight, and to place them at convenient angles. A rough form of ladder is occasionally seen, made of a stem of a tree, from 6 to 10 in. thick, with notches cut in it. Of course it is only employed for temporary purposes, but it stands much knocking about. In South America, however, ladders of this kind are used most improperly on a large scale, and, worse still, they are placed nearly upright. Things are very different on the Continent of Europe. In the case of the Samson Mine, at Andreasberg, out of 420 fathoms 350 fathoms are fitted up with the fahrkunst, and in most deep mines in England the man-engine is now employed. When the man-engine is made, as it usually is in England, of wooden rods, 6 or 8 in. square, with iron steps, holdfasts, guides, and so forth, its weight is rendered very considerable, and much power is required to work it. Experiments have been tried, therefore, with a view to lessen the weight to be sustained. Thus, in descending, certain parts of the engine are arranged so that the men ride (say) 10 fathoms, and then step off and go 5 fathoms by ladders, and so on. Again, the rods have been lightened by using two wire-ropes at about 8 in. asunder, the steps being suspended by means of brackets firmly lashed to the rope by wire. Another plan is by lightening the rods gradually from the top downwards, so that while the top is 36 in. wide in a suitable depth it is reduced to 12 in. wide at the bottom. The lower portion, and especially when it is thus lightened, is very apt to vibrate, and this is partially obviated by fixing between the two ropes three-quarter or inch boards, and also by passing the ropes at the bottom over a pulley, and tightening them by screws.

Each of these rods carries a weight of 121 cwts., made up as follows:—

Double wire-rope, 700 fms. ....Lbs.	5600
Steps, hold fasts, wrought-iron portions, binding, &c.	2200
Fifty men	7500
275 fms. of guides' planks for stuffing the rods..............	6795=22,095

When the shaft is inclined guards have to be provided for the ropes at various points. Although the cost at the Hartz mines can hardly be compared to what it is here, it may be mentioned that the cost of cutting the shaft where it wanted enlarging was 750l., whilst the wire-rope and all the fittings cost 1134l. In mines here the machinery often costs 1500l. or 2000l. for ordinary depths; but this much deeper shaft in the Hartz by these contrivances was worked by a moderate size water-wheel.

We now pass to another part of our subject—namely, the consideration of the actual excavations of the mine. These may be divided into three classes; horizontal galleries or levels or drifts, shafts vertical or more or less inclined, and the workings by which the mineral sought for is removed. The first of these divisions may be again divided into seven different descriptions of work, according to the circumstances to be dealt with. These are—1. Exploratory levels. —2. Ventilating drifts, called air-ways.—3. Ordinary levels, called road-ways, rolley-ways, or bord-gates.—4. Adit levels for introducing water into the mine. —5. Drainage levels or adits to convey the water from the workings.—6. Adits of large size and permanent character, intended to unwater whole districts.—7. Levels used as canals. In looking at these different classes of excavations we shall find a considerable difference in shape, those in the metalliferous mines being generally arched, with water running along the bottom, while those in the stratified districts are mostly rectangular, and sometimes broader than their height. I will say a few words with respect to each of these different classes of excavations.

1.—Exploratory levels or drifts for merely temporary purposes are generally of small dimensions, although no regular rule can be laid down for them in that respect. In the older workings they were often so small that a man must go double to walk through them. Sometimes when a couple of costeaning pits are put down, an exploratory level will be driven between them, so narrow that it can only be passed through by creeping and crawling. As a rule this system, now-a-days, is discarded. It was found that, besides inconvenience to the men, the disadvantages of small levels far outweigh any saving in their construction, particularly as regards ventilation. In Yorkshire, however, especially in the Richmond mountain limestone district, there are yet in use what were called "dark drifts" and hand levels," which are only 4 ft. in height, and 2½ or 3 ft. in width, just giving room for a man to pass through in a constrained attitude, and, of course, with much fatigue and inconvenience, pushing before him a little wagon, called a "driving wagon."

2.—Ventilating drifts are also of a variable size. Occasionally they are made very small, and even smaller than the Yorkshire drifts, that being considered economical, although it is a poor economy to make drifts for the conveyance of air of too small a size. They are generally 2½ feet by 3 or 4 feet; in stratified deposits it is more usual to have the ventilating drifts made of the same size as the principal working roads of the mine. In Staffordshire, for instance, where there are enormous seams of coal, 30 or 40 feet in breadth, the ordinary travelling roads are 7 or 8 feet in height. Where a separate opening is cut as the air-lead, there is danger, if small dimensions are adhered to, when the top or sides are of a crumbling nature, that the ventilation will be rendered extremely feeble by falls of material, besides rendering it difficult of travelling through to clear away obstructions.

3.—Ordinary levels and roadways often depend, in metalliferous mines, on the width of the lode. They used generally to be between 3 or 4 ft. high; and when visitors have the misfortune to be obliged to travel through the whole level, they find it very painful to adapt themselves to such miserably small dimensions. They are, to be sure, shaped like a coffin, giving a little more room for a man's shoulders, and narrowed in at the feet; but when anyone passes through, the air can scarcely get by him. These were invariably the dimensions of the old mines, and there are some now in existence which can be traced back to the time of the Romans. From the end of the last century an improvement began to set in, until at length they were made 5 or 6 feet in height, and from 2½ feet to 4 feet wide. During the last 30 years it has been sufficiently shown by the practice of all the better mines, both on the Continent and in this country, that it is best to have a clear height of 7 ft., and as large a width as from 4 to 5 ft. Even in those mines in Yorkshire, with such small air-ways, the main levels have a clear opening of this area; and if timber or stonework has to be put in, room should be left, so that there will be a height of 7 ft. and a width of 4 ft. In the Foxdale Mine, in the Isle of Man, where the lode is very variable, being sometimes large, and sometimes almost invisible, and where very strong timbering has to be put in, the dimensions kept are 7 ft. by 5 ft.

4.—Adits for conveying water into the mines ought to be carried at a moderate downward inclination.

5.—Drainage levels, or adits, are very similar to the galleries I have already described, but it is seldom necessary to resort to the larger dimensions I have spoken of. It is, however, of the greatest importance to the health and comfort of the miner that a good water channel should be established. Too frequently the drainage is allowed to run along the bottom of the roadway, and the men have to walk through it. The water very often is exceedingly cold, and the men who have to do this are much troubled with rheumatism. If a mine be one in which there is a large quantity of water, it is necessary to make the adits 8 feet high, so as to have a floor, and leave the men room to walk. It is sometimes necessary to make the adits of such proportions as to allow for the passage also of air currents. In the coal districts these adits are made so small as to be mere "soughs," but in metalliferous mines that cannot always be done.

6.—Adits intended to unwater large districts, comprising many square miles, and to receive the waters of several mines, must be made 9 or 10 feet in height, and of proportionate breadth. Works of this kind are often remarkable examples of successful engineering skill, and are marked with much boldness and permanance. In the Clausthal district of the Hartz great undertakings of this kind have followed each other, with inestimable advantage to the mining interests of these regions. In one case a great distance was accomplished in a short time by sinking shafts on the line of the adit, and then driving right and left towards each other, so that ten or a dozen different sets of men could be employed at once. This adit is 18 miles in length, and it drains the country through which it passes to a depth of 200 fathoms, and a large stream passes out of the mouth, or, as it is sometimes called, the tail of the adit, designated by the Germans "mundloch," a word not usually found in dictionaries. It is useful, however, to have a knowledge of the technical phraseology of different countries and districts at home; as, for instance, a person accustomed to the North of England only might not understand that an adit was meant by the North Country term of "sough." After an adit has been in use for years it may become necessary to replace it by another, which is then called the deeper level. A very important point for the mining engineer to look to in works of this kind is the angle of inclination at which the level is driven. That inclination should be such as will ensure a good fall to carry off the water, but yet it ought to be kept as near the horizontal line as possible. Even supposing a level to be driven for the ordinary purposes of exploring, it becomes a matter of great moment to know in what direction it is going, and that will depend much upon the judgment of the mine manager, while in exploring an unknown country this is of still more importance.

7.—Canals, which are comparatively rare, but some enormous works of this nature were carried out at the end of the last century by the Duke of Bridgewater, on whose canal boats of large size brought the contents of the mines from the dark deep bowels of the earth into the daylight.

In driving levels the manager must be careful to see that the dimensions fixed upon are adhered to. The workmen are apt to get out of the direct line if they meet with softer or easier ground in the midst of hard and difficult work, and so sometimes the level will imperceptibly increase in dimensions to a degree now and then, which will add to the expenses of the timbering requisite to secure the level, and also to the cost of removing the material dug out. Neither should the men be allowed to contract the size. Another caution in driving levels is to take care that the rise of the sole is not too great, for the miners are very apt in hard rock, and particularly in wet ground, to rise too rapidly, and the manager must from time to time step in and insist on the sole being cut down. This should be done frequently, as otherwise it may lead to great grumbling if there be much to cut down; in fact, there is no work which repays the labour and trouble of a close supervision while it is going on so much as that of driving the levels of a mine.

GEOLOGICAL SOCIETY OF LONDON.

Jan. 27.—J. GWYN JEFFREYS, F.R.S. (Treasurer), in the chair.

Arnold Lupton, Salter Gate, Chesterfield, and Dr. George Rogers, of Longwood Asylum, Bristol, were elected Fellows of the Society.

The following communications were read:—

1.—"Notes on Graptolites and Allied Fossils occurring in Ireland," by W. H. Baily, F.G.S. (First paper.)

2.—"Notice of Plant-remains from Beds Interstratified with the Basalt in the county of Antrim," by W. H. Baily, F.G.S.

3.—"Remarks upon the Basalt Dykes of the Mainland of India opposite to the Islands of Bombay and Salsette," by G. T. Clark, F.G.S.

4.—"On Auriferous Rocks in South-Eastern Africa," by Dr. Sutherland: communicated by Sir R. I. Murchison. Fourteen years ago the author expressed the opinion that gold would be found in the metamorphic rocks of Natal. A few months since Mr. Parsons found this metal by washing the iron-sand of some of the southern rivers of the colony. The gold is in microscopic rounded grains. Dr. Sutherland considers that the gold is diffused as minute particles in the granite and gneiss underlying the Silurian rocks of South Africa. These old gneissic rocks are very much contorted, include extensive veins and lenticular masses of quartz, and are traversed by basalts. The Silurian strata, resting unconformably on the gneiss, have been invaded by igneous matter (which is never granitic), and, though generally horizontal, are frequently flexuous, and in some places greatly faulted, to the extent of even 1000 ft., together with the gneissic rocks beneath. These latter have been deeply eroded by the rivers, frequently to the depth of 500, 1000, and even of 3000 feet in some valleys; and in the alluvia of these valleys the gold occurs. The valleys have sometimes evidently commenced in great displacements, forming "valleys of elevation," on which the denuding agency has been operating ever since. In certain mountains in the basin of the St. John's River, Natal, dioritic rock traverses the secondary strata; and along the line of contact it contains copper ores, with 100 grains of gold to the ton.

Mr. DAVID FORBES was glad to find that Dr. Sutherland corroborated his views as to the occurrence of gold in two ways:—

1.—In auriferous granite, as in Wicklow and elsewhere.

2.—In eruptive diorite, a basic rock without free quartz, and certainly of post-oolitic date, almost always accompanied by copper veins. Most Californian alluvial deposits of gold were derived from this class of rocks.

In constructing some of the railways of South America the granite was found

to be so soft, from decomposition, that it could be cut with the pick and spade, and this softened granite when washed produced gold.

Prof. T. RUPERT JONES considered that, by means of Dr. Sutherland's communication, the Laurentian and Silurian rocks were now, for the first time, to be recognised as existing beneath the *Dicynodon* rocks of the Natal ridge.

On Wednesday, the following communications will be read:—1. "On a Ridge of Lower Carboniferous Rocks crossing the Plain of Cheshire," by E. Hull, B.A., F.G.S.—2. "On the Red Chalk of Hunstanton," by the Rev. T. Wiltshire, M.A., F.G.S.—3. "On the British Post-glacial Mammalia," by W. Boyd Dawkins, M.A.

THE INSTITUTION OF CIVIL ENGINEERS.—At the meeting of this Society, on Tuesday, Mr. Charles Hutton Gregory (President) in the chair, fourteen candidates were duly elected, including four *Members*—Mr. Joseph Haywood Watson Buck, Resident Engineer of the Standedge Tunnel Works, on the London and North-Western Railway; Mr. Thomas Dale, Engineer of the Corporation Water Works, Hull; Mr. Peter Greck, Chief Engineer for Railways in the Imperial Russian Service; and Mr. Henry Johnston Wylie, Westminster. Ten gentlemen were elected *Associates*, as follows—Mr. John Bowden, Deputy Borough Surveyor, Salford; Mr. Alfred Mountain Fowler, Borough Surveyor, Leeds; Mr. Chas. Hart, Parsonstown; Mr. Bicamire Moody de Michele, Resident Engineer, Recife Drainage Company, Pernambuco; Mr. Joseph Musgrave, Bolton; Mr. Eyre William Preston, Assistant Engineer on the Great Indian Peninsula Railway; Mr. Alfred Lewis Sacre, Manager of the Yorkshire Engine Works, near Sheffield; Mr. Harco Theodorus Hora Siccama, Engineering Staff of the London and North-Western Railway; Mr. Augustus Horace Strongitharm, Assistant Engineer, Furness Railways; and Mr. Joseph William Wilson, Craven-street. It was also announced that the Council had recently admitted the following candidate a Student of the Institution—Joseph Pomfret Van der Meulen.

SOCIETY OF ENGINEERS.—At the meeting on Monday, Mr. F. W. Bryant (President) in the chair, a paper was read on "Explosive Compounds for Engineering Purposes," by Mr. Perry F. Nursey. The following candidates were balloted for, and duly elected *Associates*—Messrs. Charles Cockburn Gibbons, of 4, A, Great George-street, S.W., and Alfred Rubery, 12, Dowgate-hill, E.C.

Original Correspondence.

CRADDOCK'S HOT-AIR ENGINE.

SIR,—I hope you will oblige me by supplementing what appears in your Journal relative to my invention since May, 1867, up to this date, by giving insertion to the following references and remarks, as I think they are relevant to a just public opinion upon the subject. Your pages bear me witness that from 1843 to 1847 I had, upon practical data, arrived at the conclusion, and set it before the public, that by this invention the British nation had an annual value of 20 millions sterling presented to it for its acceptance, and I added that unless such was the case the invention was worse than nothing. There are men who can conceive what such a sum would do to feed the hungry, clothe the naked, and educate the ignorant. Of course, in those days Craddock's statements were said to be all moonshine, but now, and for some years past, practically, the value of my basis is seen to be so great that claims of the dead and the living have been made to it, and strange fantastic tricks have been played through the Patent Office. Among such claims are those put forward for Watt, Haycraft, and Gill. Watt's and Gill's claims are refuted in the "Engineer" by the writings of those persons (see March, 1858, pp. 245, 334, and 370, Dec., 1859, p. 460). This has to do with the views of Sims, Jan., 1861, pp. 26, 104, 218, and 236; July, 1862, p. 39; *Mining Journal*, June 25, 1864, p. 647.—This letter also refers to boiler explosions, and the right to the origination of much that was new in connection therewith, "Engineer," Nov., 1866, p. 365, *Mining Journal*, June, 1867, pp. 370, 390, 426, and 593; Jan., 1859, p. 54.

In these letters will be found evidence that places it beyond doubt who is the author of that "truth and grandeur which (even my enemies were constrained to admit in the 'Engineer' of April 12, 1861, p. 236) was just then being generally acknowledged." Yet, strange as it is, in the same leader the public is there treated with the following:—"In looking beyond the results of anterior practice, there was nothing left to Mr. Craddock but the monopoly of his single crank-pin engine." To give the reader a fair view of this leader, which seems to have been composed under circumstances similar to that of a Queen's Speech, each one of a company contributing a paragraph, I give the following:—

"When we come to look upon Mr. Craddock, however, as an ardent advocate and practical introducer of the kind of engine in question, he then claims our respect and sympathy. That he struggled hard, applying all his fortune, faculties, and time to the work he had undertaken is most true. He is, indeed, a martyr to a cause, the truth and grandeur of which are but just being generally acknowledged, and every week brings forth a list of untenable patents for contrivances which are in some way accessory to the reformed practice, and which, whatever their value, Mr. Craddock used long ago. There are details employed by several engineering firms during the last five or six years, the use of which is secured by Mr. Craddock's patents, which these firms should acknowledge, and tender proper royalties. If this act of simple justice be not voluntarily rendered we have only our clumsy and costly legal system to thank that it cannot be otherwise recovered."

Whoever looks at this leader, in which the writers were constrained to insert such a paragraph as the above when they were engaged in stripping me of the very credit of my invention, will ascribe it to the homage which justice extorts from injustice. The "cause of truth and grandeur was then being generally acknowledged;" because, as the leader states, Craddock's patents had expired some two months before that date. Thus you have this monstrous proposition, that though it was my basis with the structural details that produced that "cause the truth and grandeur of which just then was being generally acknowledged;" yet, in that same leader, we are told that by anterior practice there was nothing left for me to do before 1840. One of two things here must be true, either the engineers of the world had or had not this basis embodied in structural details, and the practical value it thus embodied presented in actual work, brought home to their minds with the same evidence as that they have of the sun shining, as by my invention it was by me for 18 years held up in practice to their and the public gaze, so that Englishmen could not fail but perceive its practical value, and how such value could be in a more or less degree given to the steam-engine, in proportion as the less or more complete invention was used. Suppose, as the "Engineer" implies, that they did know it from the time of Oliver Evans and Watt, have not those two men, and all the engineers down to 1861, been enemies to mankind in thus robbing it of a "cause so full of truth and grandeur?" But if they did not know it they could not impart to mankind that which they had no knowledge of themselves; who but those looking through the haze of engineering jealously can doubt which of these alternatives is the true one.

How natural also is the time chosen by the "Engineer" to announce to the world the general acknowledgment of a "cause so full of truth and grandeur" as that when the inventor's rights were confiscated, and he being stripped of all else it was but natural to strip him of his credit also. But, as all the following names have been used against me, I put the questions thus short—Did Savery invent and reduce to practice such a combination of principles as form my basis, and get in his day such practical results from it as I did, for 18 years, after 1840? Did Newcomen? Did Watt? Did Trevethick? Did Hornblower? Did Woolfe? Did Oliver Evans? Did even the Cornish engineers, with their cumberous and localised engine? Did Hall? Did Napier? Did Sir Charles Dance? Did Perkins? Did Griffiths? Did Macerone? Did Gray? Did Dr. Haycraft? Did Gill? I know, and others may know if they will honestly examine and understand what my basis is, that taking all the disjointed productions of all those men and put them together they are in total darkness as to the cause why practice with the crank-engine upon the expansive principle was unproductive, until pioneered by me, and until I had turned that darkness into light by the lamp of practice, which revealed a far more destructive cause of cooling from the steam itself, in such expansive engines, than that which Watt found in the injection water in Newcomen's steam-cylinder.

In this day all must see that once Watt had seized the cause of the loss in Newcomen's engine, and devised one set of means by which in practice he effectively removed it, as shown by its every-day work, that afterwards other modes could readily be devised which, by the use of his basis, would effectually realise a saving upon Newcomen's engine in proportion as the means used, more or less, neutralised the cause of loss Watt discovered in Newcomen's engine. On this point again, like means in my case have led to like results; nor can any really original comprehensive inventor, especially in the steam-engine, guard himself against pirates by any kind of specification, unless the right to property in the basis be granted, where, in fact, the property he makes really, for the most part, exists, justs as it lies more in the land itself than in the buildings, roads, and water-courses, of which land is the basis. Thus we find Boulton and Watt, after spending 70,000*l.*, were very near being robbed of everything, as I have been. Yet, until they made and proved their basis, designers and builders could no more make such engines than can the farmer grow corn without land.

But if Watt and Craddock had not made each basis, someone else would, is the exclamation of men, who thereby imply that if their property is protected by law, why care about such men as Watt and Craddock. Let such persons remember that that which they make their property to-day, in most cases others would (if they did not) make it their property on the self-same day. But inventive property is not of that naked kind that all who seek can find, much less can those find who by nature and culture are disqualified for the work. Hence Watt's basis is by him and Boulton expanded to the full by 1800, and the subsequent 40 years added little to it; but in the next 17 years my basis is as much developed by me, against no end of opposition, as Watt had developed his by 1800. The men who deny justice to such men as Watt and Craddock deserve to want bread for 40 years, and then they would comprehend with how much more force is the argument applicable to them, that had not their property been made yesterday by them, it would, therefore, to-day have been made by others; and they would be thus made better judges why, as they should be protected in the right to the property they made yesterday, although others would have produced it to-morrow, and more clearly perceiving that between 40 years and two days there is the difference to wanters of bread of near 40 years of dearth, they would also see and believe that Watt and Craddock were as much as themselves entitled to have their property protected.

In relation to the claim put forth for Dr. Haycraft, in the matter of my basis, the doctor, like the others, shall speak for himself. But, before proceeding to quote the doctor, the reader should know that the doctor's brother, an entire stranger to me, called twice upon me during the delivery of my lectures in Birmingham, in January and February, 1846. He was inquisitive upon the internal cooling question; suspecting nothing at the time, I replied to his questions without reserve, but the reader will see his object hereafter. Our reference will first be to an article found in the "Mechanics' Magazine" of April 11, 1846, p. 267, and to a letter of the doctor's, found Oct. 12, 1850, p. 288. The reader is also referred to the doctor's specifications of his two patents; the first is found in 1830, No. 5942, and the latter April 15, 1846, No. 11,167. In the article found in the Magazine of April 11, 1846, the reader is told that a patent had then been obtained, and that Mr. John Penn was experimenting upon the invention; but it will be seen that the patent is dated April 15, 1846, and that the result of this invention in practice did not give so great a reduction of coal per horse power per hour as mine with nothing but atmospheric condensation, and the old boiler quantity of 8 lbs. of coal for each 62 lbs. of steam generated, did in 1843. In this article the reader is referred to the Transactions of the Royal Society of Edinburgh, and the first volume of the Transactions of the British Association. In the 10th volume of the first-named work, at p. 195, is found all the doctor makes public in those works, but there is not one word having the slightest reference to the question in hand. We are, therefore, justified in concluding that as neither in the article of April 11, 1846, nor in the doctor's letters of Oct. 12, 1850, is there any other reference given than these and those to the Patent Office, that they give all that had been made known to the public. We, therefore, find in the Patent Office, 1830, not a word indicating any effort made to use steam expansively, nor not even one word about internal cooling, until suggested to the doctor by his brother. But we find the doctor's object was to dilate steam by heat, as Sterlin and Ericsson dilated air. A want of candour is manifest in these two documents found, as given in the "Mechanics' Magazine," both as to antedating and the suppression of dates. In that of April 11, 1846, is found the following:—"A patent has been taken out lately for improvements in the steam-engine, the principle of which we understand is founded on the use of anhydrous steam."

"The inventor, Dr. Haycraft, has been known by his various publications in the Royal Society of Edinburgh Transactions, and in the first volume of the Transactions of the British Association, chiefly in relation to the Atomic Theory. It is some years since, *if we mistake not*, that Dr. Haycraft developed his theory on the use of anydrous steam, which is founded on the fact that if water be deposited in the interior of a cylinder it subsequently is evaporated every time the eduction valve is opened, and by its evaporation tends constantly to cool down the cylinder in a ratio proportioned to the evaporation, and consequently to the quantity of water deposited in the cylinder. The theory itself is novel, and derives strong support from the facts of the case." It is my doings that the words, *if we mistake not*, are in italics, as the sequel will show that what above follows those words had no such significance in the doctor's mind until the brother's suggestions set the doctor upon the practical path. Now, we go to the doctor's letters of 1850. "The attention of your readers has been attracted by the communications in your Journal of Mr. Frost, of New York. He has with much talent developed his views on dry or anhydrous steam, which, on the supposition of its having its own atomic constitution, he denominates *stame*. He has given experiments, which open a vast field for improvement, and his conclusions lead us to believe that the power of the steam-engine may be prodigiously increased. Having about 20 years since entertained nearly the same views as Mr. Frost, and having reason to modify them, it may not be amiss to give an historical detail of the principal facts on which those opinions were founded.

"It will be at least advantageous to the reader, by warning him of those errors by which I have been mislead, and will at the same time open to him the right path to improvement. Being induced by the experiments of Broughton, who supposed that steam was 10,000 times rarer than water, and by those of Desagulier, who puts it down at 14,000, I experimented by weighing steam in a copper ball, and afterwards weighing the same after having been immersed in boiling oil for some time, for the purpose of superheating and rarifying the steam. The particulars of this experiment I need not detail, as it is, I now perceive, liable to the same objections as Mr. Frost's, which I will afterwards explain. The result was that, by exposing steam to the temperature of boiling oil, its specific gravity appeared to be lessened to about one-tenth—that is, it expanded to about ten times its former bulk. Encouraged by this apparently satisfactory experiment, I had a small engine constructed, with a cylinder of 4 inches, and furnished with a tubular condenser, by which I could measure exactly the quantity of steam consumed. The cylinder was furnished with a jacket, which was supplied by a high-pressure boiler. On working the engine with ordinary steam, it required 85 revolutions to fill a given measure with condensed steam; on applying steam to the jacket of about 500 lbs. pressure, it required 920 revolutions to fill the same measure, the engine carrying the same weight on the paul. In this experiment, which was often repeated, it appeared that dry steam, or Frost's *stame*, is ten times more economical than ordinary steam. Having succeeded thus far, a high-pressure non-condensing engine was erected, with a 9-inch cylinder and 3-feet stroke. The cylinder was constructed so that a fire could be made round it, and, at the same time, the supply of steam passed through tubes exposed to the heat of the furnace flues. The engine worked very well for some time, and with surprising economy of fuel; but, as might be expected, the parts exposed to high temperature gave way, and the engine became useless. It, however, occurred to me one day to ask myself what could be the reason that Watt in his best engines lost half the steam."

Here his brother is represented as supplying him with the solution of the difficulty, which is that found quoted above from the article of April 11, 1846, and then the doctor exclaims all became quite clear. The doctor is wrong in supposing Watt lost half his steam in his full pressure engines, as in Farey's work Watt says he had reduced the loss from that of one-half in Newcomen's engine to less than a quarter in his engine.

I have quoted thus fully all that can in the slighest degree favour the doctor, but the reader should bear in mind that what I have quoted from the doctor's letter was not written until 1850, and from the article not until April 11, 1846. But, nevertheless, we have not one word about the internal cooling due to expanded steam, as is found published by me in the *Mining Journal*, Dec., 1845, p. 679; was related in my lectures between Feb. 10 and 15, 1846; and, again, published in "Bradshaw's Railway Gazette," Feb. 28, 1846, p. 478 and 507; and, again, in the *Mining Journal*, March 21, 1846, p. 119, see also next number. The doctor had no idea of using steam expansively in all that is quoted, nor does he seem to have much more inclination to the use of steam expansively in his patent of April 15, 1846.

If we take the mere evaporation of water from the hot cylinder we have Watt aware of it, we have Farey aware of it, we have Gill aware of it; and, indeed, it is difficult to conceive of any person pretending to any practical knowledge of the steam-engine as not being aware of it. But until seized and published by me there is no one of them that give the least indication that he was aware of the fact that steam itself became so destructive a cooler in the steam-engine when used expansively, yet I put it before the public from the first that *this internal source alone* was such that expansive engines must fail in the economy anticipated from them, unless such internal steam cooling was neutralised.

It is the seizing of the cause in this case, as in that of Watt in the cylinder injection, which is the great point which gives the sure and stable basis upon which to raise engines, such as mine or Watt's, with that success, certainty, and economy which alone can give great property-value to such inventions. This internal steam cooling, that was seized and neutralised by me, is far more destructive of power in the high-pressure, expansive, and condensing engine than was that of the injection water in the steam-cylinder of Newcomen's engine, which Watt neutralised. The proofs of this do not rest on theories or words, but on the result which each of us practically established by the working of our engines for years, and is expressed in the coal per horse-power per hour, which each basis thus in practice established as the measure of the actually realised property in each invention.

Now, as it is shown above that mere evaporation from the cylinder of water was from the time of Newcomen's engine at least well known; so, also, is it well known that Watt produced his steam-case to prevent the air cooling the cylinder, so as not to produce this deposition of water, and the consequent evaporation due to such cause (see "J. B.'s" letter in the "Engineer," April, 1858, p. 315); and, then, we have Woolf and others proposing hot oil and liquid metals, and a variety of expedients, and Haycraft with his steam at 500 lbs. pressure in the case. On the other hand, you have Tredgold demonstrating that such modes of retaining the heat in the steam (see letter in the "Engineer," April, 1858, p. 334) was inferior to good non-conducting clothing. The reason of these diverse views and modes is found in the facts that they, one and all, scarce ever extended their views in this matter beyond the non-expansive engine; and when they do, as in the case of Gill, they conclude that expansion would in itself reduce such source of cooling. In a word, they confine their attention to an original cause extraneous to the steam-cylinder, and overlooked the original inherent internal cause due to the steam itself in the steam-cylinder, which is of immeasurable more practical importance, and is in the steam itself when used at high-pressure expansively, and condensed in a vacuum. If I were to try forever I cannot explain in a more generally comprehensible form the quiet and concealed way this cause exists, and operates to render expansive engines even more lavish in cost of coal than non-expansive engines, if this cause be not neutralised, than I did in paragraph 133, extracted from my manuscript pamphlet, and found June, 1867, in the *Mining Journal*, at p. 371. From that paragraph any persons can see, who are neither scientific or engineers, that the warm clothing of Tredgold, or the steam-case of Watt, as he used it for a number of years (see "Engineer," Dec. 1859, p. 460) in his single-stroke engines, would effect scarce anything towards neutralising such cause, or admit of an economical expansive steam-engine being produced. And, also, why the long and slow-stroke Cornish single-acting engine did to some extent neutralised this cause, when the steam-case was rendered a distinct receptacle, with steam at boiler pressure in it at all times; and how, owing to the long and slow stroke, more time was given for the reassumtion of the particles of water into that of steam before the power stroke of the piston ended; all this is from paragraph 133 easily deducible. And had Doctor Haycraft had sound views of the steam-engine, so as to have directed him to use the high-pressure expansive engine, and practical tact enough to have detected the real cause of so much mystery and loss, he, with his 4-in. cylinder condenser and high-pressure boiler, was upon the right road to success, but his mind was turned in quite another direction, and one which many others have travelled in vain. Amid all this bobbing about, it was the obliviated Craddock's lot to render this question plain, and to build upon his own foundation and principles structures which are practically universal in their application, and produce a degree of economy and other valuable recommendations beyond what he has claimed for them.

To sum up the whole, then, my invention consists in the use of steam from 30 lbs. up to 400 lbs. pressure per square inch, and in the use of this steam expansively in conjunction with surface condensers and vacuum. The condensation being produced by water where obtainable, and where water is not obtainable then by the atmosphere, and as by my discovery of the cause why such engines had but very little property-value, I was enabled to place this class of engine upon as practical and stable a foundation as Watt did his engine, and I neutralised this cause by all the best means, which means or mechanical structures are explained in detail, and which I was the first to conjoin together, so as to form the complete engines upon this basis, and by long practice proved their value, and conveyed to others a knowledge of such law and combined principles, and how to construct such engines, boilers, and condensers, and set them to produce such results as I had myself for years verified in every-day work before the public, and explained through the public journals current among those best fitted to understand the subject.

I say this places my claim to the Expansive Steam-Engine, in all that it differs from what it was up to 1840, or, at least, 1843, on quite as high ground as Watt's claim to the leap from Newcomen's engine to his, can lay claim to. Therefore, I say, that as he only enhanced the 1 lb. of coal twofold, and I have enhanced the value of the 1 lb. of coal at leat seven and fourteenfold, that as his engine was confined to large supplies of water, and the use of mine is as illimitable as that of man's existence in this world, it is unsound and unjust logic that places the value of his invention to mankind as greater than mine. Much more, is it most unjust to treat me as I have been treated. I meddle not with engines I found in use, and pay no regard but to the expansive engine; and I took it up at the point others left it, in the full conviction it could not be further improved. Therefore, let my practically established results have the same weight in the decision of the question as those of Watt. Not to do this to the person who not only invented but manufactured and kept the invention in every day use before the public for 17 years, thus instructing others throughout all that time to imitate and perpetuate it, is such an injustice as no man ever before experienced in any nation, at the will and pleasure of his countrymen, whom he had so served.

In relation to Rankine's one-hour experiment in the Thetis, candid persons who reflect will see that liability to error does not depend upon the time so much as upon the mass of water and matter in the boiler, and the mass of coal upon large grate area, as these were but as one to eight of the common practice; with equal care the chance of error in the one hour is not greater than that of eight hours upon the common practice. Let the objectors, instead of giving isolated indicator figures, which alone are no proof of economy in their crack expansive engines, do as Rankine and I have done—present all the other elements. In 1843 I weighed the steam water, which, with the indicator figures taken, could leave no doubt, unless in an adverse direction. In 1854 (see *Mining Journal*, p. 699) I weighed the steam, water, and coal for several successive days together, and found $12\frac{1}{4}$ lbs. of steam per 1 lb. of coal. (See *Mining Journal*, Feb. 1849, p. 82, on my condenser in water. See "Engineer," May, 1858, p. 405, on my condensor in air, and the reasons why I could prosecute that part of my invention no longer.) Among the curious documents in the Patent Office is one of Thomas Howard, of the King and Queen Iron Works, dated June 5, 1859, No. 1524, "On Condensing Steam-Engines," when superheated steam is used. This is clearly an afterthought. Let any man make a property as I have, and claimants beyond number will present themselves. THOMAS CRADDOCK.

44, *Friston-street, Birmingham, Jan.* 30, 1869.

[For continuation of Original Correspondence, see this day's Journal.]

CALCINING FURNACES.

The ordinary method of heating a close furnace is by passing the flame between the two arches at the top, and then once or oftener under the tiles which form the bottom of the furnace. The invention we are about to describe, and which has been patented by Mr. J. B. Brown, of Walker, Northumberland, consists in converting the space between the two arches into an open furnace, to which the ore or mineral is first supplied. The ore afterwards descends into the space below the lower arch, which space forms the close furnace. Mr. Brown levels the top of the lower arch so as to form an upper bed to receive the ore. This lower arch is strengthened, and the distance between the two arches is made sufficient to allow the ore to be worked on the upper bed or top of the lower arch. The flame passes first over the ore on the upper and open bed, and then under the ordinary lower bed to the chimney. By means of this invention the smelter is able to get rid of any excess of sulphur on the upper bed before adding common salt or other chloride to the ore in the lower bed or close furnace. The gases from the two beds are kept separate and distinct, those from the lower bed being collected and condensed, if necessary. Should it be desired that the ore on the upper and open bed be subjected to a lower degree of heat than when in the lower bed or close furnace, this is effected by causing the flame from the fuel to pass first under the tiles which form the floor of the lower bed, and then ascending to pass over the ore on the floor of the upper bed, and thence to the chimney. It may also be effected by causing the flame from the fuel to pass under the tiles of the lower bed, then between the arch of the lower bed, and a set of tiles made to form the floor of the upper bed, and then finally over the ore on the upper bed to the chimney.

Fig. 1 of the accompanying engravings is a sectional view of a combined close furnace and open furnace, constructed according to this invention. A is the lower bed or close furnace; B is the lower arch, and C the upper arch; D D are the spaces or flues under the tiles of the lower bed, A; E E are the working doors. He levels the top of the lower arch, B, to form an upper bed, F. The flame passes first over the ore on the upper bed, F, and then under the lower bed, A, through the spaces, D D, to the chimney. If, as we have before explained, it is desired that the ore on the upper bed, F, should be subjected to a lower degree of heat than that on the lower bed, A, the flame is caused to pass first through the spaces, D D, and then to ascend and pass over the ore on the upper bed, F, to the chimney. Fig. 2 represents a modified arrangement of Mr. Brown's furnace, in which spaces or flues, G G, are formed between the lower arch, B, and the upper bed or open furnace, F. In this furnace the flame is caused to pass through the spaces, D D, then through the spaces, G G, and finally over the ore on the upper bed, F, to the chimney.—*Mechanics' Magazine.*

FIG. 1.

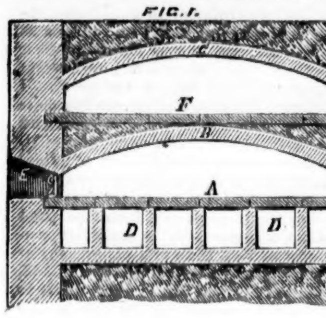
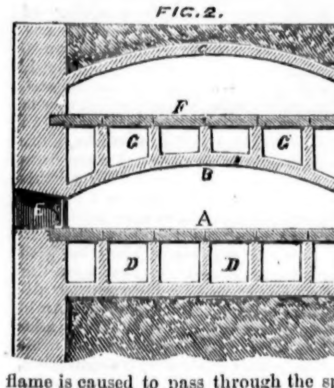


FIG. 2.



FOREIGN MINING AND METALLURGY.

Some days of rigorous cold have communicated a certain activity to the Belgian coal trade. The demand at the collieries is a little more sustained than in former weeks; nevertheless, merchants still show a certain hesitation, and confine their orders to the supply of strictly necessary requirements, and stationary prices indicate the sentiment which animates the market. In the Liége basin the demand for coal for domestic purposes is somewhat active; in coke business has been done at a slight advance. The basin of the Couchant de Mons remains in a depressed condition, and although the demand has become rather more active, the production has been reduced to about one-fourth its full amount in almost all the collieries, while stocks remain stationary. The coalowners of the province of Namur have just formed an association in order to defend the interests of the local coal trade. Each colliery delegate is to have one vote, and no decision is to be binding if a majority of the members of the association are not present. The association is to hold an ordinary meeting on the first Thursday of each month. The President and the secretary are charged with the execution of the resolutions adopted at general meetings. Each member is to contribute to the expense of the association; if one or several of them are delegated for a special mission, all the associated collieries are to sustain their share of the expenses which may be incurred. The association is to last three years from Jan. 15, 1869; and it will be decided at the meeting of Dec., 1871, if the organisation shall be continued for a further period. M. Cavenaile, managing director of the United Collieries of the Lower Sambre, has been appointed President of the Association. An unofficial table, which has been prepared by a Belgian firm, calculates the total amount of the exports of Belgian coal to France in 1868 at 3,226,378 tons, while the quantity of Belgian coke exported to France last year is set down at 193,131 tons. In 1867 the corresponding totals were 3,014,452 tons and 232,984 tons; and in 1866, 3,393,649 tons and 292,793 tons. The deliveries last year by the canal from Mons to Condé were 46,120 tons of coke and 853,203 tons of coal; by the Sambre, 1052 tons of coke and 629,932 tons of coal; by the railway to Jeumont, 33,583 tons of coke and 802,743 tons of coal; by the Valenciennes line, 9443 tons of coke and 53,000 tons of coal; by the line from Mons to Hautmont, 97,822 tons of coke and 645,820 tons of coal; by the line from Mouscron to Lille, 320 tons of coke and 151,379 tons of coal; and by the line from Tournai to Lille, 4791 tons of coke and 99,304 tons of coal.

The pig-iron trade continues to improve in Belgium. Refining pig is quoted in transactions of little importance at 2*l.* 16*s.* to 2*l.* 16*s.* 10*d.* per ton, but in long-termed contracts—contrary to the rule observed in France—it is stated that forgemasters would not accept less than 2*l.* 18*s.* per ton. In assuming this attitude it would seem that they have great confidence in the future. It is true that the requirements of consumption are considerable, and that a notable improvement has occurred of late in prices; but the fact must, nevertheless, not be lost sight of, that the very least event might bring back the absolute stagnation in affairs from which the trade has only just escaped, so that one would think that long-termed contracts ought to be regarded as beneficial to an industrial establishment. However this may be, the chances are certainly in favour of an advance in prices; stocks are everywhere almost exhausted, and the requirements of consumption continue to develope themselves on a large scale. A re-adjudication of 9600 tons of rails, required for the Belgian State railways, is awaited with a certain impatience. A Royal decree, dated Jan. 16, 1869, authorises Messrs. Walthery Brothers to add to the works which they possess at Sawheid, in the commune of Embourg, two trains for rolling plates, and two heating furnaces. A project has been brought forward for the formation of a company for working blast-furnaces owned by M. Dupont, of Châtelineau, which have been extinguished for several years past. The Belgian General Company for Lighting and Heating by Gas—which has works at Arras, Bergues, Cambrai, Catana, Charleroi, Chemnitz, Dunkerque, Fourmies, Herstal, Louvain, Marchienne-au-Pont, Prague, Rimini, St. Omer, Sienna, Tournai, and Valenciennes-Anzin—sold in September, October, November, and December, 1868, 137,955,005 English cubic feet, as compared with 130,360,775 English cubic feet in the corresponding period of 1867, showing an increase of 7,574,230 English cubic feet in the first four months of the company's current year's working. Meetings are announced as follows:—Fainuée Collieries Company, Feb. 9, at Gand; Piéton-Campagne Colliery Company, Feb. 15, at Charleroi; Quaregnon United Collieries Company, Feb. 23, at Quaregnon, &c.

There is nothing very special to report this week in the general state of French metallurgy. All the works are provided with orders for some time to come, and, in consequence of this, the orders arising from one week to the other are without any influence on the tone of the markets, which remains firm. In the Haute-Marne, although the demand for charcoal-made pig has been important, prices remain as hitherto. Mixed pig has been dealt in at 3*l.* 8*s.* to 3*l.* 9*s.* 8*d.* per ton. Meurthe pig is offered at 2*l.* 12*s.* 10*d.* per ton at the producing works; but for some time past the transactions with this group and the Moselle have become insignificant. The state of affairs is the same as regards iron in the Meurthe. In the Moselle the iron market maintains great firmness; transactions are very restricted, but, irrespective of current affairs, a considerable number of back orders are stated to require attention, and as regards some articles, manufacturers are said to find it impossible to guarantee deliveries at fixed periods. In all the blast-furnaces the production is being forced on to meet the more pressing wants of the rolling-mills. Rough pig is quoted at present at 2*l.* 13*s.* 10*d.* to 2*l.* 14*s.* 8*d.* per ton, as regards small contracts of less than 100 tons; and 2*l.* 12*s.* 10*d.* per ton, as regards important contracts. It appears that the revenue of the Parisian Company for Lighting and Heating by Gas amounted in 1868 to 1,342,741*l.*, as compared with 1,328,094*l.* in 1867, showing an increase of 14,647*l.*, or 1·10 per cent. Of the increase of 14,647*l.*, 12,026*l.* occurred in December, 1868. It is remarkable, however, that any increase at all should have been established in the company's revenue last year, considering that 1867 was the year of the Paris Universal Exhibition. The Huelva Mines Company is paying at Paris a fresh sum of 1*l.* 4*s.* per share, in respect to back interest due on the share capital.

Copper has displayed rather less favourable tendencies of late on the French markets. At Havre, Chilian in bars has been quoted at 74*l.* 6*s.* per ton, Paris conditions (deliveries at the end of January); the latest quotation was 75*l.* per ton (deliveries at the commencement and end of February), and 76*l.* for 15 tons (deliveries at the end of March). Refined Chilian and Peruvian in ingots range from 78*l.* to 80*l.* per ton, and Lake Superior from 88*l.* to 90*l.* per ton. At Paris, prices have presented no material variation, Chilian in bars standing at 75*l.* per ton, ditto in ingots 79*l.* per ton, and Corocoro minerals 78*l.* per ton. At Marseilles, transactions have been moderate, and prices have remained without change, Toka being quoted by continuation at 72*l.*, Spanish at 74*l.*, refined Chilian at 78*l.*, red copper for sheathing 84*l.*, and yellow ditto 80*l.* per ton. At Berlin, prices have differed but slightly from those which have prevailed of late at that centre. At Hamburg, stocks are small, and the article has displayed an upward tendency. Banca tin has shown some weakness at Havre; the quotation for brilliant Banca has been 114*l.* to 117*l.*, and for Straits 112*l.* to 116*l.* per ton. At Paris, there has been only a moderate current of affairs in tin, Banca being quoted at 116*l.*, and Straits at 114*l.* to 116*l.* per ton. At Hamburg, the tin market has been firmer, and prices have slightly advanced. On the Dutch market, there has been some diminution in activity during the last few days. At Rotterdam, the disposable stock has made 68 fls., while for future deliveries 69 fls. has been paid; business might even be done, it appears, at 68¾ fls. At Amsterdam, some sales have taken place at prices ranging from 67 fls. to 68 fls. Quotations for lead have been very well sustained at Havre and Paris, soft Spanish, first fusion, having made 19*l.* 4*s.*, and lead from other sources 19*l.* 6*s.* per ton. At Marseilles, lead in saumons, first fusion, has made 17*l.* 14*s.*; ditto in shot, 18*l.* 18*s.*; and rolled and in pipes, 20*l.* 12*s.* per ton. On the German markets, the more recent advices indicate much more firmness. At Hamburg, also, the tendency is firmer. At Rotterdam, Stolberg and Eschweiler has made 11½ fls., and German of various marks 11⅝ fls. The tendency of the Paris and Havre zinc markets has been tolerably good, and prices have remained firm. On the first of these markets 20*l.* 8*s.* to 20*l.* 16*s.*, and on the second 20*l.* 14*s.* to 20*l.* 16*s.* has been paid for Silesian.

FOREIGN MINES.

St. John del Rey Mining Company (Limited).—Advices received February 2, per steamer Danube, *via* Southampton.

MorroVelho, Dec. 29.—General Operations.—During the past fortnight we have had more moderate weather, the supply of water has been good; but the heavy humid atmosphere we have had since the continuous rains has greatly interrupted our work in the Gamba Mine, where the air has been so heavy and wanting in oxygen, as to prevent lights burning in the excavation, even up near the surface. Arrangements are being carried into effect for the ventilation of this mine, which we hope will be completed within a few days, and it shall then be fully supplied with borers.

Mines.—Having been excluded from the Gamba Mine, we have had more native borers than we could advantageously employ on the stoping spaces now being worked, and yet I have been unwilling to discharge these men, knowing that in a short time we shall want them, when we shall have more profitable space for their employment. A supply of stone from the places worked has been obtained of about the average quality, and the stamps generally, excepting the Costesworth, have been kept fairly supplied with mineral. The quality has been as good as the localities being worked could give. We have had a small quantity from the East Cachoeira, and we are still receiving a little from the West Quebra Panella, but the chief stoping places have been Nos. 3 and 4 stulls Bahu, and a little from the West Cachoeira above the bar. The pump has acted well in keeping down the water, notwithstanding the heavy rain fall we have had, and the large excavations of both mines being now drained by one pump.

Gaia and Gabiroba.—The roads have improved a little since the date of my last advices, and we have been unable to keep up a full supply of good mineral for the stamps during the past two weeks. The road from Gabiroba becoming occasionally quite impassable for carts, we were obliged to have recourse to mules for the conveyance of some mineral from thence to Gaia.

Reduction Department.—The required supply of stone has been in part drawn from the killas depôt below the spalling-floors, though nearly the average quantity has been received from the mines. Sometimes the heavy repairs of the stamps caused considerable stoppage, nor has it been practicable to keep the Costesworth constantly supplied during the holidays. Otherwise the general stamps having had a full supply of water have done quite average duty, and have been kept at full speed while at work. The spalling has been done as usual, and the amalgamation process has gone on with regularity and fair results.

Praia.—Having a very large supply of water, the stamps and arrastres at these works have been driven at full speed. The killas available for the retreatment of the sand in the stamps is of very inferior quality, so that we cannot expect even average returns from this section of our operations.

Gold Extracted to Date.—The produce of the stamps for the second division of December, being a period of 11 days, amount to 2488 oitavas. It has been derived as follows:—

	Oitavas.		Tons.	Oits. p. ton.
From General stamps	1794	from	1409·9	= 1·272
Herring ditto (Gamba and Cachoeira)..	694	„	409·7	= 1·695
	2488		1819·6	= 1·367

GAIA STAMPS.

	Oits.		Tons.	Oits. p. ton.
From Gaia and Gabiroba ore	413	from	275·0	= 1·502

The foregoing produce, though not quite so good as that of the second division of the previous month, is better than that extracted in the first division of this month. During this period we have only had 179 tons of stone from the Gamba Mine, for reduction in the Herring stamps, the remainder reduced in that stamping-mill having been obtained from the Cachoeira Mine; we have not, therefore, had the ordinary supply during the above division from the Gamba Mine, from which we are still excluded, but we shall resume working there the beginning of next month. There is reason to conclude we have now got through the worst circumstances of supply, and that our returns may more nearly approach the monthly cost in future.

Modified Working Plans.—We are trying at present whether the ore accessible at the points previously named in the Bahu will cover the cost of its extraction from the mines, and treatment in the reduction department. An interruption to our working the Gamba Mine, owing to the want of proper air there since the recent wet weather, has prevented us from having the opportunity of trying the ore from that mine at the same time, with the view of ascertaining how far the entire produce from these places might go towards covering the general outlay of the company under present circumstances.

The air has improved in the Gamba, and lights have been taken down to the sump, so that in a few days we hope to resume stoping operations in that mine.

We have withdrawn from working the East Quebra Panella, and now our operations will be concentrated on the Gamba, and such parts of the Bahu and East Cachoeira as will fairly cover the expense incurred in working the same. At Gaia we cannot at present increase our stoping plans, owing to the falling in of the old workings, and the covering thereby of the best part of our stoping space. The excavation is now being secured above, and then the debris will be removed, and the stoping below resumed on its previous scale.

It has been unfortunate that we should have been subject to interruption in the two best places we have had for obtaining produce at the same time, especially when we feel more than at any previous period the smallest decrease in our gold returns.

New Shafts.—The timbering up of the lower half of the shaft A has been more tedious than was anticipated, owing to the amount of clearing away of the sides, as the respective circles of segments were about to be fixed. The lower 5 fathoms having been sunk in irregular killas, which was difficult to sink evenly in a true circle, and quite plumb, entailed more labour in trimming than was estimated when that work was begun. At the shaft B the sinking has been carried on, and hard killas reached apparently in a settled bed, crossing the bottom of the shaft. The level reached is nearly now the same as that of shaft A. The portion sunk through will now be timbered up, as the ground immediately above the killas in the bottom is rather soft, and not trustworthy. The progress made during the past two weeks has not been quite so good as previously effected, the timbering especially in shaft A having impeded the sinking.

Don Pedro.—Jan. 1: Produce to date, 15,864 oits.; estimate for December, 19,500 oits. Operations have progressed satisfactorily. A little box-work taken out from No. 5, and the general stopes from curve yielded well. We are stoping northern and southern sides of this body of lode. At the exploratory works there is nothing new to report. At the shallow adit there is no improvement. Even with average ground, before 200 fathoms can be driven a long time must elapse, and the work be attended with very heavy cost. Taking this into consideration, the small extent of "backs" that will be drained by the same adit, and that from the nature of the ground "runs" may take place and endanger the works above, since Capt. Treloar has been here other measures have been under consideration that will supersede this said level. Treloar's level is progressing in a most satisfactory manner.

Anglo-Brazilian.—Our operations both in and out of the mine, have been greatly retarded since my last, through want of force; but this is no more than we expected, as at the present season of the year several of the hands go to their homes for the Christmas holidays. In the appearance of the lodes there is little or nothing new to note. Dawson's canoa on the southern side maintains favourable features, and in stopes from Dawson's shaft the lode continues to yield well. The latter, however, is becoming slightly disordered with killas.

Rossa Grande.—The lode at the eastern end of the main level has again improved, its size increasing from a few inches to upwards of 2 feet. No alteration calling for special notice has occurred in the features of the lodes at the other points of progress.

Sao Vicente.—Jacotinga Formation: The progress at No. 2 cross-cut has not been so great as I expected, owing to the party who has taken the contract not working very regularly; consequently, we have not yet intersected the bed of jacotinga referred to in my letter of the 15th ult. To the west of our present works, in the curve of the mountain, there is an open cutting, which appears a favourable place for intersecting the jacotinga formation by a cross-cut. We have commenced to pass som ejacotinga through the "canoa," to see if any traces of gold can be found, but I am sorry to say to date have been unsuccessful. I am pushing on with all possible dispatch the works at the smithy, but owing to our small force of mechanics the progress is slow. Captain Thomas Treloar has apprised me of his intention to visit this mine in a day or two, when some definite plan will be decided upon for carrying on operations at the jacotinga formation.

Taquaril.—The deep adit proceeds slowly, on account of the rocky nature of the ground they are driving through, but this difficulty is expected to be only of short duration, when greater progress will be made. The rocks are pyritic in character, and some specimens have been pulverised and washed, and have produced traces of gold. The superficial adit for giving a more copious supply of air to the deep shaft has been completed, and the deep shaft has been recommenced. The superficial adit for the pumping rods is being pushed on with vigour. There is much timber work requiring to be attended to here, yet with common luck we may reasonably expect this work to be concluded in about two months, or by the end of February, 1869.

Imperial Silver Quarries.—L. Chalmers, Dec. 22: I am sorry that I cannot report more favourably as to the rate of running. The rock last week was worse than ever, and only 7 ft. 9 in. of tunnel run. To-day we have struck a softer seam, which I hope may last.

Jan. 4.—There were 7½ feet of tunnel made last week. There is no such obdurate rock in the country as that through which I am now driving; it drills badly, and blasts worse. Giant powder is more efficient than ordinary powder, but it is very costly, and the men cannot stand it for any length of time; I use it, however, occasionally, and with advantage.

Rhenish Consols.—George Swest, Jan. 28: Christiana; The lode in the eastern end, in the 20 lachter level, will afford 1 ton of lead ore per lachter. The western end in this level will also afford 1 ton of lead ore per lachter. The distance between the extreme points of these ends is now about 30 lachters, and the lode for this length has afforded fully 1¾ ton of lead ore per lachter. A stope in the roof of the 20 lachter level, and east of Pittar's winze, will afford 2 tons of lead ore per lachter. A stope in the roof of this level, and west of the cross-cut, will afford 1½ ton of lead ore per lachter. A stope in the roof of the 10 lachter level, and west of Sweet's winze, will afford 1½ ton of lead ore per lachter. Sunk in the engine-shaft this month 1 lachter; total depth attained below the 20 lachter level, 4 lachters.—Bliebach: The end driving west on the middle lode, in the 10 lachter level, will afford 1 ton of lead ore per lachter. A stope in the roof of this driving [illegible] will afford 1½ ton of lead ore per lachter. We have four tribute bargains on the middle lode, and two on the north lode, varying in price from 3*l.* 10*s.* to 4*l.* per ton for clean lead ores. A cross-cut is being extended south from the western end on the north lode in the 10, and north on the copper lode in the adit level. Estimated returns for January month:—Lead ores, 550 centners, 1580 ths.; blende, 60 centners, 60 ths. = 1640 ths.; total cost on mines, exclusive of block, 1750 ths. Sinking Astley's shaft, 325 ths. The breakage to Bliebach engine, and heavy floods of rain about the same time, caused suspension of operations in the bottom level for nearly three weeks, which made against our returns, and also the bringing of the ores to surface; and during the last week our dressing operations have been suspended through the severity of the frost, but I am glad to state that the weather is again very mild, and dressing resumed.

Pestarena United.—Thomas Roberts, Jan. 25: At the Val Toppa Mine we are pleased to report an improvement that has taken place in the end of a level driving in the mountain, above Marmo Rosso level. The lode in the bottom of this end is now 2 feet wide, and as we advance the ore is rising up. We have not yet made a trial of this ore, but have no doubt as to its being rich in gold, particularly as it has the same appearance—quartz and pyrites—as that extracted in a deeper level on this lode. The lode in the ends driving on the flat, or new lode, and the stopes on the quartz lode, are much the same as last week. At Pestarena Mines, the 46 fathom level end, south from the Aquavite engine-shaft, has improved. We expect to reach the course of ore before this end shortly. All other places not mentioned continue much the same as last week. The cold weather is making very much against our floor hands at the present time in dressing the ore at Pestarena. The water in the Anza continues to fall off, working at the present time 86 small mills at Pestarena. No deficiency of water at Battigio and Piedimulera establishments.

[For remainder of Foreign Mines, see this day's Journal.]

Spon's Dictionary of Engineering.—The first three numbers of the dictionary bearing this title (and to which reference has already been made in the *Mining Journal*) have now been issued, and appear fully to justify the favourable anticipations which had been formed of it. No. 3 extends so far as to include the commencement of the article "Angular Motion or Velocity." Already several subjects of interest to miners and metallurgists have been referred to—the definition and comments upon the words "Adhesion," "After-damp," "Air-chamber," "Air-engine," "Alloys," and the several forms of "Amalgamating Machine" being highly interesting. The article "Anemometer" is an elaborate and really useful treatise upon the instrument and its application, and one which may be profitably studied by all connected with the management of mines, and especially of coal mines. The insertion of the corresponding technical terms in French, German, Italian, and Spanish adds much to the value of the work, for it must be admitted that it is precisely for the technical words of a language than even the professional man is most likely to be at a loss; but with this dictionary before him he can express himself at once, for he will find, for example—"AMALGAMATION PAN: Fr., *Poële à amalgamer*; Ger., *Amalgamamir-pfanne*; Ital., *Macchina per amalgamare*; Span., *Hornillo para cocer amalgamas*," and then an admirable description of the machine referred to. The quality of the engravings and the style of the printing are all that can be desired—indeed, the fact that it is printed by Messrs. Clowes and Sons is a sufficient guarantee in this respect. It is intended to complete the work in about sixty shilling parts, which will be issued fortnightly, and there can be no doubt that the opportunity offered for obtaining a really valuable and elaborate work at a very moderate price will be largely availed of by the superior class of working engineers, as well as by those occupying higher positions in the profession.

Steam, Air, and Gas Engines.—The February number, the ninth, of Mr. Bourne's "Examples of Modern Steam, Air, and Gas Engines" contains a large plate of Boilers constructed at the Hartlepool Iron Works, 1868, and numerous engravings in the text. The remarks on Coal Burning Locomotives are concise and to the point, affording every facility for arriving at correct conclusions as to the relative merits of each of the principal arrangements which have been proposed. The same may be said with regard to the remarks on Foreign Goods Locomotives. The character of the work is well maintained.

Palæontological Researches.—The last published volume of the "Journal of Natural and Economic Science," issued under the direction of the "Committee of Improvement," attached to the Royal Technological Institute of Palermo, contains an enormous amount of useful information, amongst which may be noticed a translation from the "Philosophical Magazine" of Mr. J. Gill's paper "On the Temperature of Steam evolved from boiling saline solutions," and a most interesting treatise "On the Fauna of the Limestone Formation, with Terebratula janitor of the North of Sicily," by Prof. G. G. Gemmellaro, the object of the writer being to establish with precision the relation of the grey limestone with Terebratula janitor to the other calcareous formations in the same district. This paper is illustrated with an engraving of Monte Pellegrino, and four beautifully executed plates of fossils. There is a vast quantity of meteorological informations, collected at the Royal Observatory at Palermo, and recorded in a most systematic style. The journal seems well calculated to facilitate the progress of the society with which it is connected.

Commercial Retrospect for the Past Year.—For some years past "The Railway, Banking, Mining, Insurance, and Commercial Almanack," by Mr. W. Page Smith, of the "Railway Record," has enjoyed a high reputation for the elaborate and impartial retrospect of the preceding year contained in it, and the edition for 1869 is not less valuable than any which has preceded it. The almanack forms a volume of considerably more than 200 pages, and embraces an annual review of the material interests of the United Kingdom; notices of coal, iron, metal, cotton, &c.; and a variety of miscellaneous information useful to the merchant, the manufacturer, and the general public. The articles are of an interesting character, and all relate to topics of present interest, including such subjects as Heaton's Steel Process, the Land and Building Societies, the British Manufacturing Interests, and the supply of Raw Cotton, Life and Fire Insurance, &c. As an almanack, Mr. Smith's book contains all the usual information; and as a review of the commercial and general progress of the country during the past year it is worthy of a permanent position as a work of reference.

The Manufacture of Watches and Clocks.—A most interesting and instructive little work, describing briefly, but with great clearness, the rise and progress of watch and clock making, has just been published by Mr. J. W. Benson, of 25, Old Bond-street, 99, Westbourne-grove, and the City Steam Factory, 58 and 60, Ludgate-hill. The book, which is profusely illustrated, gives a full description of the various kinds of watches and clocks, with their prices, and no one should make a purchase without visiting the above establishments or consulting this truly valuable work. By its aid persons residing in any part of the United Kingdom, India, or the Colonies, are enabled to select for themselves the watch best adapted for their use, and have it sent to them with perfect safety. Mr. Benson, who holds the appointment to the Prince of Wales, sends this pamphlet to any address on receipt of two postage stamps, and we cannot too strongly recommend it to the notice of the intending purchaser.

London: Printed by Richard Middleton, and published by Henry English (the proprietors), at their offices, 26, Fleet Street, E.C., where all communications are requested to be addressed.—*Feb.* 6, 1869.